Aesthetics and Usability of Virtual Learning Environment Interfaces

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Submitted for the degree Doctor in Philosophy

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March 2007

Abstract

There are many theories about what good aesthetics are and how they can be achieved. However, the importance of aesthetic attributes in the design of interactive computer systems has only recently come to the attention of researchers. The research described here uses design fundamentals (e.g. Gestalt theory, design principles and dynamic symmetry theory) as a model to manipulate the aesthetics of a Virtual Learning Environment (VLE). Another part of the thesis is concerned with the surprising fact that aesthetic have a role to play in determining judged system usability.

The research is organized in three parts. The first part is about VLEs and how the communication features support online learning. It also presents a review of how aesthetics can be applied to graphic screen design. The second part presents an observational study of the use of a VLE and its communication tools. The third part presents four experiments that manipulate aesthetics and measure the effect on users. Experiment 1 evaluated the use of design principles on interface design and found that participants preferred the screen layouts that applied the design principles. Experiment 2 used a VLE prototype where the participants had to navigate through the interface and found that aesthetics influenced judgements of system usability. Experiment 3 was similar to the second, however, with a stronger manipulation of aesthetics and usability and showed an even greater effect of aesthetics on usability. Experiment 4 showed that order of rating did not affect the above conclusions. In summary, the experiments suggest that interface aesthetics play a substantial role in the evaluation of the usability attributes of a VLE.

The research contributes to the fields of Human Computer Interaction and Graphic Design by further explaining the relationship between aesthetics and usability.

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Acknowledgements

Completing this thesis was a highly personal achievement, and without the support of others I could not have succeeded. First, I would like to thank Andrew Monk, my supervisor, whose research expertise provided a solid background for the research. As well as a supervisor he has also been a very good friend. I would also like to thank Nick Hammond, my former supervisor, for his support during difficult times and for his friendship.

I would like to thank my research committee members, Peter Thompson and Tim Andrews. I am also grateful to the former research committee members Peter Hatcher, who retired in 2005, and Andrew Monk.

I would like to thank Malcolm Wren, Darren Reed, David Grayson, Gordon Baxter and Hokyoung Ryu for their support and advice. I would also like to thank my friends Ahmad Khamesan and Jasem Alostad for their friendship and encouragement during this research. Many thanks also go to João Mansano Neto and Elizandro Ribeiro for helping in developing the prototypes as well as those who helped collect data.

As well as those individuals who assisted me in the academic process, there also others who have been equally important in terms of personal support. I would like to thank my friends in Brazil, Marlise Cantu and José Aguiomar Foggiatto

On a personal note, I would like to thank my beloved family, my husband Richard and my son Ricardo for supporting me through these years. Also, my father Rovilio, my mother Marlene, my sister Emanuelle and my mother-in-law Dorothy.

Declaration

Some of the material presented within this thesis has previously been published in the following papers:

Parizotto-Ribeiro, R. *et al.* (2004). The importance of Aesthetics on the Perceived Usability of VLEs: Preliminary Results. Workshop Design, Meaning Maker: Rethinking Relationships for a more creative HCI, 18th British HCI Group Annual Conference, Leeds, UK.

Parizotto-Ribeiro, R. *et al.* (2004). Aesthetics and Perceived Usability of VLEs: Preliminary Results. VI Simpósio sobre Fatores Humanos em Sistemas Computacionais, Curitiba, Brazil.

Parizotto-Ribeiro, R. and Hammond, N. (2004). What is Aesthetics anyway? Investigating the use of design principles. NordCHI 2004 International, Tampere, Finland.

Parizotto-Ribeiro, and Hammond, N. (2005). Does Aesthetics Affect the User's Perception of VLEs? 12th International Conference on Artificial Intelligence in Education (AIED2005), Amsterdam, Holland.

Parizotto-Ribeiro, and Hammond, N. (2005). Virtual Learning Environments through design principles: what the experiments reveal. 11th International Conference on HCI, Las Vegas, USA.

All the work contained within this thesis represents the original contribution of the author.

Dedication

To

My parents, Rovilio and Marlene

and

My husband Richard and my son Ricardo

Chapter 1

Summary of the thesis

1 THESIS OVERVIEW

The research undertaken for this thesis focuses on the role that aesthetics play in the usability of computer interfaces, focusing on Virtual Learning Environments (VLEs). Part I establishes the theoretical background for this research. It covers the issues related with the VLE and the aesthetic aspects related to interface design. Part II describes an observational study that illustrates the way students use a virtual learning environment during one online course to collaborate and communicate with each other. Part III describes four empirical studies about aesthetics and usability in a VLE.

1.1 Part I – Literature review

Chapter 2 covers the conceptual background about Virtual Learning Environments and how they are being used to deliver distance education.

Chapter 3 reviews related literature that underpins and outlines the concepts of this study. This mostly comes from the research into principles of layout composition and interface design. It covers empirical studies that discuss the relationship between aesthetics and usability. It also covers Gestalt and Emotional Design theory.

1.2 Part II – Use of communication tools on a VLE

Chapter 4 shows how the participants of one online course use the features provided by the environment to communicate with each other. The data was collected from the observation of the students' interaction with each other, with the lecturer and with environment. It allowed synchronous communication and the participants were geographically separated. It was concluded that the practical problems that arise conducting reality studies in this way were considerable and hence the research focus was switched at this point.

1.3 Part III – Aesthetics applied to VLE

Chapter 5 presents the first experiment and is intended to test the importance of the design principles to develop screen layouts for a Virtual Learning Environment (VLE). The experiment was divided into three parts. Part 1 tested the importance of five design principles (unity, proportion, homogeneity, balance and rhythm) which were drawn from the Gestalt theory of perception and were chosen because of their representative meaning and the appropriateness for this research. Part 2 investigated the application of these design principles on three different screen layouts and used dynamic symmetry theory to generate the grid to be used as the backbone of the screen layout. The last part used a paper questionnaire to collect data on the hedonic attributes of the screen layouts.

The experiment aimed to test the importance of the aesthetic attributes for the screen layout design using the design principles and the relationship of aesthetics and perceived usability of an interface.

It involved 279 participants divided into seven groups. The results showed that participants preferred the screen layouts that follow all five layout principles.

Chapter 6 presents the second experiment, aimed at identifying the relationship between the aesthetic attributes and the usability attributes of an interactive virtual learning environment interface. It used an interactive VLE prototype which was developed specifically to collect data for this experiment. It used the dynamic symmetry technique to build the grid and applied the design principles tested in the previous experiment. This time the participants would navigate through the environment before evaluating the aesthetic and usability attributes.

It involved 98 participants divided into four groups. The results showed that the manipulation of aesthetics affected the ratings of aesthetics and usability attributes. However, the manipulation of usability did not affect any of the ratings.

Chapter 7 is about the third experiment, on aesthetics and usability of a computer interface. This experiment was similar to experiment 2; however, the aesthetic and usability attributes received a stronger manipulation than they had in experiment 6. Also, this time a *training* interface was introduced where the participants would have a first exposure to the environment type and task before using the *measured* interface.

It involved 88 participants divided into four groups. The results showed that the aesthetic attributes had a large influence on the way participants rated usability. This experiment also revealed that the stronger manipulation had the expected effect, so that usability attributes were significant in the way usability was rated.

Chapter 8 extends the findings of Chapters 6 and 7, adding the rating order variable to ascertain the results obtained in the three previous experiments. The experiment itself was quite similar to experiment 3 and the reason for introducing the rating order variable was to counterbalance the order of

aesthetics and usability manipulations ratings. The previous experiments always rated aesthetics prior to the usability rating.

In this way, this last empirical study expects to check if the rating order could have affected the results. It involved 267 participants divided into eight groups. The results confirmed the extremely large effect that aesthetic attributes have on the usability ratings of an interactive interface. Also, it shows that the order of rating did not have any influence on the ratings of aesthetics and usability attributes, confirming the results found in experiments 2 and 3.

Chapter 9 – Conclusions and future work concludes the thesis by summarising its contribution to the research on aesthetics and the usability of computer interfaces. It also discusses the research limitations and suggests directions for future research.

In addition to the main body of this thesis, we provide seven appendices to help the reader to understand the experiments carried out during this research. We made extensive use of the Authorware[1] from Macromedia® to develop the prototypes used in experiments 1, 2, 3 and 4.

Appendix 1 presents the questionnaire used for the observational study on communication tools.

Appendix 2 presents the material for the first experiment on aesthetics. There were five screens presenting the five design principles used, twelve layout screens where the design principles were considered, one screen comparing the

[1] Authorware is a multimedia authoring tool made by Macromedia and it is used for creating interactive material.

e-mail layout, hedonic attributes questionnaires, screeplot graph and participants' pictures.

Appendix 3 presents the experimental package with the screen layouts of the interactive interface used in experiment 2. In a similar way Appendix 4 includes the experimental package for experiment 3. Appendix 5 shows the flyer which was used to give feedback to participants. Appendix 6 provides the screen layouts for the *training* interface used in experiment 3.

PART I

Literature review

Chapter 2

Literature review: Virtual Learning Environments

1 INTRODUCTION TO LITERATURE REVIEW

Some years ago the personal computer started to be part of our everyday life. A major concern was to make the computer interface easy to use and easy to learn, in other words, usability was the most important issue.

Nowadays the personal computer is being used for many other tasks than office work and it is used in many other different ways than before. For office work the computer is used as a device to learn from, and so it may be important to emphasize the user's satisfaction as well as the pleasure of using it as a learning tool.

In the light of recent studies on perceived usability and aesthetics plus Norman's arguments about beauty from his book Emotional Design (2004), this research finds strong support for its main hypothesis that aesthetically pleasing interfaces have a positive effect on user satisfaction.

The role of aesthetics in human affairs has been widely documented. Aesthetics probably relates to our appreciation of computer systems as well (Maquet, 1986: In Ngo, Teo and Byrne, 2000). Therefore, this literature review will report the scientific studies that provide evidence that the aesthetic attributes of the interface play a great role in affecting system usability and acceptability.

To explore how these findings are related to the interfaces of Virtual Learning Environments (VLEs) it is necessary to investigate the specific characteristics of this type of interface. What makes one interface, of a particular software, work better than the other? What aesthetic and graphical aspects are most likely to influence the user satisfaction, engagement and enjoyment?

O'Leary (undated) defines VLE as software products that aim to support learning and teaching activities across the Internet. These types of software are used to deliver learning of many kinds and in many formats.

VLEs are different from office systems because they do not have the same user requirements as office software. Some of the requirements are driven from the nature of the task and duration of the course using a VLE. For example, they are used for a much shorter period of time than office software (e.g. one hour every day during one year). Therefore, they need to be much easier to learn and use than office systems because users cannot spend a long period of time learning how to use them.

Using a computer to deliver learning is a challenging issue as the VLE needs to motivate and engage students that may be geographically separated and studying at different times of the day.

This literature review is divided into two parts. The first part is about VLEs and how they are being used to deliver distance education and support online learning. The second part covers the aesthetics aspects that can be applied to computer interfaces such as VLEs.

2 INTRODUCTION TO VLE

This first part of the literature review will discuss Virtual Learning Environments and their role, as a modern medium, to deliver distance education. Distance education can be defined as the education that takes place when teachers and students are separated by time and space (Sun Microsystems, 1998). This model of learning has been used for a long time to provide informal education in many countries, even in emergent countries like Brazil. Typically, it used printed materials delivered by mail where the students received a book, went through its content and had some kind of formal evaluation at a certified educational institution.

During the last decade the increasing development and dissemination of technology made the Internet-based learning, especially the Virtual Learning Environments (VLEs), the main focus of modern distance education and they became an important area of research, investigation and development of online learning. The flexibility of online course materials provides instructional opportunities for acquiring, exchanging and reflecting on the real significance of information for the students (Jain and Howlett, 2002).

3 WHAT IS A VLE?

There are many definitions of Virtual Learning Environment. The most relevant are the following:

'Virtual Learning Environments offer an integrated solution to managing online learning, providing a delivery mechanism, student tracking, assessment and access to resources' (Milligan, 1998).

'VLEs are software products that aim to support learning and teaching activities across the Internet' (O'Leary, undated).

'A virtual learning environment (VLE) is software that provides a shell or framework for putting a course online. VLEs provide a convenient way to create online courses for either remote or local delivery that can be run as stand-alone modules or in support to traditional teaching' (Lewis, 2001).

'Virtual learning environments (VLEs) are on-line domains that permit synchronous, collaborative interaction among instructors and students, while also providing asynchronous learning resources for individualized use by students at any time (VLE: Introduction, 1996).

These definitions of VLEs are mainly based on the technical features they have to offer in order to support learning and teaching across the Internet.

So, it could be said that Virtual Learning Environments are software products that aim to support learning and teaching across the Internet by providing a delivery mechanism for the content material, support for communication among participants, course management, and access to a variety of resources.

Some VLEs are more tutor-centred than others. These VLEs typically place the learning material at the centre of the system and provide some tools that the student can use as he or she progresses through the material. So, the main focus of these systems is the management of the delivery material (e.g. WebCT).

Others adopt a more student-centred approach. These types of VLEs put emphasis on t he communication tools to support collaborative learning (e.g. CoMentor). The collaboration among students can be synchronous (e.g. chat) or asynchronous (e.g. e-mail).

Finally, there are some VLEs that are a mix of the two approaches above. These VLEs also adopt a student-centred approach but the main focus is not on collaboration. The students have the option of collecting together and

constructing a set of resources relevant to their own way of understanding the learning material (e.g. COSE).

The interface design of VLEs is likely to be important as they support quite sophisticated learning, teaching and communication styles which should support novice, intermediate and expert users at the same time. The VLEs needs could be closely related with the effect that aesthetic attributes have on the user's perception of the interface.

4 FEATURES OF VLE AND THEIR CLAIMED VALUE

The Virtual Learning Environments have a number of features and tools in order to facilitate and support a complete online learning and teaching experience. The VLE's features should be designed to serve a wide range of users and support a variety of tasks and communication. This can be relatively complicated to achieve and needs a well-designed interface.

The most common features and tools of this type of environment are described below.

4.1 Content delivery

Content delivery is the main feature for most of the commercial VLEs. It provides study materials and learning resources for the students. The content is provided, usually, in advance and the students can access this content and study at their own pace. There might be some guidance or rules on how to use the material to achieve the best results from each course.

4.2 Communication tools

The communication tools are present in most types of VLE. They provide support for students and help to create the sense of community among participants that can be geographically separated.

The communication between tutors and students is the central feature of the collaborative VLEs which have a student centred approach.

The communication can be synchronous (same time, different place), using chat, audio and video conferencing or asynchronous (different time, different place) using e-mail, discussion boards.

The most common communication tool is e-mail, followed by communication boards. This kind of communication does not require the participants to be online at the same time (time constraint) and allows communication from one-to-one as well as one-to-many. The messages can be posted and the recipient has time to reflect before answering it.

4.3 Assessment

Some VLEs offer some kind of student assessment, usually formative assessment. They can be multiple-choice assessments with automated marking and immediate feedback. They are frequently used in training courses and offer an opportunity for the student to check his or her understanding about the content.

4.4 Administrative features

The administrative features offer management and tracking of students. This is an important feature for staff, w ho, through usernames and passwords, c an ensure that only registered students can access the course. The VLE can typically

give analyses of assessment undertaken by students and show how the students are using the material within the VLE.

Students are given the opportunity to have their individual web pages, electronic diaries, upload of course-work and so on.

The administrative features may include a calendar, general information about the course, important news, etc.

5 HOW VLES ARE BEING USED

Many educational institutions are using some type of environment to deliver online courses, and many more are about to start doing so. Virtual Learning Environments are also being successfully used by private companies to offer up-to-date training and re-qualification to their employees and even the government and military are taking advantage of this kind of technology. The main reason is that the benefits can easily justify the cost, especially when travel and accommodation are taken into account (Stephenson, 2001).

The use of computers potentially offers significant advantages over traditional distance education (e.g. workbooks sent by post) and is playing a vital role in this area of education. Computer technology can provide access to many different types of resources and more flexible structures of learning.

Although the computer is a good academic tool and the Internet a good resource of information, VLEs need more research to become more effective and user friendly (Jain and Hollet, 2002). This is partly because VLEs have different requirements from office systems. Apart from being effective, environments used for learning need to engage the students in a pleasing experience in order to increase motivation and time spent on tasks.

Jain and Hollett (2002) believe that when learning is completely distance based (where the participants never meet) and the students use the resources of the Internet a great deal, they tend to accept better and use it as a channel of communication and as a study tool than when the course is not entirely at distance.

This last statement was verified during an interview with a tutor (Nov/2002) from a distance course delivered by the Department of Health Economics at the University of York. The participants were geographically distributed and the only way of communication was through the communications tools offered by the VLE – WebCT. Another interesting point was that they used the bulletin board a great deal to share information, even though, for some of the participants, English was not their first language. This course is a good example of how VLEs, specially the communication tools, could support teaching and learning. The bulletin board plays an important role in facilitating the understanding of the course content through collaboration among students. The tutor also noticed that the asynchronous nature of the communication allowed the participants to reflect about their opinions and gave the non-English students the opportunity for reviewing their messages before posting them for the others.

5.1 Benefits of VLEs

There are many potential benefits of using a VLE for education and training. The flexibility of the delivery makes it possible to use the same material using different paths for different audiences; the savings when the same content is delivered online instead of printing the material for a large amount of students can be economically relevant; and, the quality of the course material could be improved when the tutor has to review the material because the act of reviewing the material can already improve its quality (Milligan, 1998).

Along with these benefits, using a VLE has the advantage that the online environments offer a good opportunity to create a sense of community and shared knowledge among participants that can be geographically separated.

There are many reasons for students to choose learning with VLE. Experiencing online learning, learning new skills, learning with others learners, participating in a richer environment and having flexible access are some of them (Stephenson, 2001).

On one hand, a very strong reason for studying online might be that one would not be able to take the course in any other way because of the constraints of time and space (e.g. mature students that work full or part time or students that live far away from educational institutions).

On the other hand, students also have reasons to avoid this type of learning. Among these are the lack of trust in online learning systems, lack of equipment, lack of IT skills and sometimes lack of confidence or motivation to study at their own pace and, maybe, space.

6 MODELS OF ONLINE COURSES

The term "online learning" can represent a wide range of learning scenarios, from courses which are supported in any way by learning technology to courses that are delivered entirely online. Mason (2002) proposes a framework to consider the wide range of existing online courses.

6.1 Content + support model

This model is the earliest and most extensive category of online course. There is a separation between the content (print or Web package) and support (usually delivered by e-mail). The course material is relatively unchanged and can be

used by many different tutors. It's called an 80/20 model, where 80% of the course is based on the content and 20% on the support.

This model represents an evolution of traditional face-to-face delivery. The content might be delivered as booklets while the support is delivered online. The content is separated from the support, making it possible to change the way in which the support is provided while the content is still unchanged.

6.2 Wrap around model

This category defines those courses that consist of tailor made materials (study guide, activities and discussion) wrapped around existing materials (textbooks, CD-ROM resources or tutorials). It is categorized as the 50/50 model, where the amount of content and support are equally important.

In this model the course is mainly or entirely delivered online. The online interaction and participation is essential for completing the course. The course material would still be static, not suffering much interference from the students.

6.3 Integrated model

The course consists of collaborative activities, learning resources and joint assignments. The heart of the course takes place online through discussion, accessing and processing information and carrying out tasks.

This model relies on active learning and collaborative working. There may be little formal learning material and the benefits to students will come mainly from critical assessment of their own work.

These models of online courses available today apply particularly to adults and mature students studying at a distance and, more especially, to postgraduate and professional levels.

7 APPLICATION OF THE MODELS OF ONLINE COURSES

The framework proposed by Mason (2002) for models of online courses could be used to help during the developmental phase of a VLE environment as it gives the environment designer the requirements needed for the VLE graphical interface. It also guides the educational technologist to relate VLE design to the educational theories which may underpin different points of the course, different disciplines and in order to approach different levels of courses, different groups of students as well as different learning styles.

The content + support model best suits courses that have an instructional approach such as technological (physical and engineering science) courses where the formative assessments can contribute to the student acquiring knowledge on a specific topic (e.g. WebCT). This model requires a predictable environment, and a direct and relatively fixed navigation style. This kind of VLE demands a technology that supports a variety of new media to present the content material and assessments to continuously motivate the students, who have the freedom, as well as the responsibility, to interpret the course for themselves.

The integrated model is more likely to follow a constructivist learning approach (e.g.CoMentor). It could suit courses on social science and the humanities, disciplines that are based on discussion such as social psychology or sociology because the heart of the course takes place online. This VLE emphasizes the collaborative learning and the dynamic interaction among the students, so it needs up-to-date and robust technology to support a great volume of information traffic, from asynchronous communication to synchronous communication, such as video, audio or text based.

The wrap around model could be said to be a combination of the other models because they need well presented content material as well as tools to support

communication among students as well as between the student and the course tutor (e.g. COSE). It can attract courses on life science that need a little bit of both approaches. This model also requires a predictable environment. However, it needs an up-to-date technology to support communication, synchronous or asynchronous, through the VLE environment itself.

8 CONCLUSION ON VLES

Good VLEs must provide not just knowledge or information, but also an opportunity for communication and reinforcement of learning through reflection, an inviting environment for collaborative activities, and clear information regarding the pacing of the course. Ideal online learning material should extend beyond being a virtual course book, to being a virtual classroom (Milligan, 1999).

The use of VLEs to deliver online learning is in its early stages and there are important issues to be addressed in order to improve teaching and learning as well as the environment itself.

This research aims to investigate how the participants of online courses perceive the use of this type of interface and the effect it has on them. The models of VLEs that will be mainly addressed are content + delivery and the wrap around model due to the nature of the interface itself, in other words, there is a predictable interface with specific features.

Chapter 3

Literature review: Aesthetic attributes

1 INTRODUCTION TO AESTHETICS

This second part of this literature review will discuss the aesthetic atributes of VLEs, their effect on the VLE interface appearance and how they might influence the users' perceptions of usability. The motivation to study aesthetic atributes applied to VLEs is that this type of computer interface is quite new and its acceptance by the user could be strongly related to its appearance, quite apart from its features.

The aesthetics of design describes the characteristics of the design that are responsible for the appearance and perception of a design artefact and can have a major impact on users' emotions and mental representations. The use of aesthetics gives a dimension to the interface that goes beyond simply decoration.

Aesthetics is much more than the study of beauty. It deals with feelings, pleasure and culture helping to reduce confusion and anxiety about and boredom with computer interfaces. Aesthetics is an important part of the human experience and, far from being opposed to function, the aesthetic is a complement to function (Norman, 2004). A well-designed artefact is, by definition, a pleasure to use.

Aesthetics has been described as dealing with 'the philosophy of beauty as well as with the standards of value in judging art and other aspects of human life and

culture' (Lawal, 1974; In Sudweeks and Simoff, 2000). The American Heritage Dictionary defines Aesthetics as 'the study of the psychological responses to beauty and artistic experiences'.

Aesthetics has been object of many investigations over the past centuries. The term has evolved over the years and has been studied from different points of view and schools of thought, including philosophy, psychology and art. Traditionally, aesthetics was only concerned with the study of beauty. However, the subject has broadened in modern times to include the understanding of how art is related to what people feel, to what they learn, and to the cultures in which they live.

2 WHY AESTHETICS MIGHT BE OF PRACTICAL USE IN A VLE

2.1 Effect on user satisfaction

The marketplace success of any product is strongly determined by its physical form and design. Hardware and software are considered products and their success is influenced by their aesthetic aspects. The Apple iMac is a clear indication that the visual appearance has become a strong factor in buyers' choice and it was well advertised as being the aesthetic revolution in computing.

The research studies conducted by Jordan (1998) on pleasure on product use suggest that pleasurable products are used more regularly.

Recent research on the visual aesthetics of computer interfaces suggests that aesthetics are a strong determinant of users' satisfaction and pleasure (Lavie and Tractinsky, undated). Lavie and Tractinsky (undated) reported that Gait (1985) claimed that more interesting interfaces increase users' arousal and sustain their interest and effectiveness.

It has also been found that beauty is a primary predictor of overall impression of and preferences for web sites (Schenkman and Jonsson, 2000) and that the visual attractiveness of the site affects users' enjoyment as well as perceptions of ease of use (Heijden, 2003).

This reinforces Chaiken's argument (1979) that the first impression often influences attitude formation and is important to shape users' attitudes towards interactive systems (Lindgaard, 2006; Tractinsky, 2006). Another study on information system use, Hiltz and Johnson (1990), found that, 'if computers were perceived initially as difficult to use, users were more likely to express dissatisfaction with the interface of the system after four months of use.' This study indicates that a user's initial impression of a system may have a significant effect on how usable the system actually is, for a given user.

This is supported by Ngo, Teo and Byrne (2003), who stated that careful application of aesthetic concepts can aid acceptability, learnability, comprehensibility and productivity.

Acceptability was investigated by Kurosu and Kashimura (1995) and Tractinsky (1997, Tractinsky, Shoval-Katz and Ikar, 2000) whose studies showed very high correlations between users' perceptions of interface aesthetics and usability.

There are also several studies related to learnability. All the studies mentioned here are cited in Ngo, Teo and Byrne (2000). Toh (1998) found that aesthetically pleasing layouts have a definite effect on the student's motivation to learn. Aspillage (1991) found that good graphic design and attractive displays contribute to the transfer of information, in other words, good design helps the user to comprehend the information in a better, easier way. Szabo and Kanuka (1998) found that subjects who used a lesson with good design principles completed the lesson in less time and had a higher completion rate than those

who used a lesson with poor design principles. A study by Grabinger (1981) indicated that organization and visual interest are important criteria in judging the readability and studyability of the real screens. Screens that are plain, simple, unbalanced, and bare are perceived as undesirable.

2.2 Effects of aesthetic attributes and perceived usability

2.2.1 Kurosu and Kashimura study

The literature suggests that the first study on aesthetics and perceived usability was conducted in Japan by Kurosu and Kashimura (1995). They used 26 layout patterns of ATM machines as a stimulus to evaluate their functional and aesthetic aspects. The participants were students from a design and psychology school (252 in total). The results were analyzed together due to the fact that both groups showed similar patterns of judgements.

Among the determinants that the interface designers consider to enhance the inherent usability the cognitive strategies of familiarity (type of pattern) and grouping (concept of perceptual grouping from Gestalt theory) stand out. This study shows evidence of the importance of aesthetics in screen layout and apparent usability of a computerized system and it looked on the effect of aesthetics on perceived usability rather than on actual usability. They explored the relationships between a priori perceptions of the ease of use of an automatic teller machine (ATM), which they termed 'apparent usability' (when the user just sees the interface without interacting with it) and appearance (beauty) of the interface. There was relatively high correlation (r=.589) between aesthetics and apparent usability, suggesting that the apparent usability is related to the aesthetic aspect (beauty) of the screen layout. This study suggests that the user may be strongly affected by the aesthetic aspect of the interface even when evaluating the functional aspects.

2.2.2 Tractinsky studies

A similar study was done by Noam Tractinsky (1997) in Israel, which produced the same findings as Kurosu and Kashimura in Japan. Tractinsky conducted three experiments to replicate and validate Kurosu and Kashimura's study concerning the relationship between aesthetics and apparent usability in a different cultural setting. He expected the correlation to be higher in Japan than in Israel due to his belief that the Japanese place a higher value on aesthetics than do Israelis.

The first experiment replicated the Kurosu and Kashimura study using the same 26 ATM layouts, just translated into Hebrew, to confirm the robustness of the Kurosu and Kashimura results to cultural variation. The 26 design layouts were presented using an overhead screen projector, for 20 seconds, in a large classroom with 104 engineering students. Students rated each layout regarding how usable it appeared to be and how beautiful it was using a 1 to 10 point scale. The results show a high correlation between aesthetics and apparent usability ($r=.921$). This suggests that the Israelis perceived ease of use and design aesthetics of anything as even more closely related than did the Japanese. In addition to that, a significant correlation was found between apparent usability and the independent variable called grouping factor (grouping of keys according to their function). Once again, Gestalt theory seems to be relevant to aesthetics.

In the second experiment, the procedure had two conditions to test for potential response dependency. In the first condition, the 81 participants evaluated the design aspects on a first round and the apparent usability on the second round, with each layout being projected, in a random order, for 15 seconds for each evaluation round. In the second condition, the participants evaluated first the apparent usability and in the second round, the design aspects. The results were

similar to the first experiment, including the influence of the grouping factor on apparent usability.

The third experiment tested for medium bias (i.e. the kind of medium used to present the stimulus material to the participants), so the overhead projection in a large classroom was replaced using a personal computer. This procedure gives more uniformity to the viewing conditions and also reproduces, in a more realistic way, real life conditions. It used a computer program to allow the participants to work at their own pace, accept user responses and record the response times. The stimulus material, 26 ATM layouts, were presented in a random order and the participants had to evaluate them using a 1 to 10 point scale. In the first round they evaluated one aspect, aesthetics or apparent usability, and in the second round, the other. The results are consistent with those obtained in the two previous experiments. Using computers made it possible to record the time participants took to evaluate the designs and, on average, usability took more time than aesthetics (mean evaluation times of 8.68 seconds and 7.58 seconds, respectively) supporting the expectation that evaluating apparent usability is more complex than evaluating interface aesthetics.

Contrary to Tractinsky beliefs, a correlation did exist between aesthetics and apparent usability in both cultures, with that in Israel being even higher than that in Japan. The similar results obtained under three different contexts and procedures suggest with some confidence that people's perceptions of aesthetics and apparent usability are, in general, highly related in a positive way.

These studies strongly suggest that it is necessary to pay more attention to people's perception of the interface aesthetics and whether the degree to which that aesthetics relate to apparent usability is culturally dependent. One possible

explanation for cultural differences is that with greater aesthetic sensitivity comes greater sophistication and critical skill.

Tractinsky (2000) conducted an experiment to test the relationship between users' perceptions of a computerized system's beauty and apparent usability. Pre-experimental measures indicated strong correlations between the system's perceived aesthetics and perceived usability and were replicated in the post-experimental tests. The aesthetic factor had three levels (high, medium and low) and the usability two (high and low).

The dependent variables of this study are subjective evaluations of interface properties. Pre-experimental perception of the interface measures three variables: aesthetics, usability and the amount of information it contains. The post-experimental phase measures four variables: aesthetics, usability, amount of information and user's satisfaction.

The experiment used nine selected ATM layout from Kurosu and Kashimura and the participants were asked to rate each of them on three aspects: aesthetics, ease of use and amount of information. They were presented in a random order. After that, the participants were assigned to one aesthetic condition to perform four types of tasks. Participants had to perform 11 tasks, which comprised the four types: inquiring about their account balance (three times), withdrawing cash (four times), checking the account balance and withdrawing cash simultaneously (two times) and depositing money (two times). The ATM system gave messages that guided the participants and gave them feedback.

The manipulation revealed the strong effect of the aesthetic factor with mean ratings of 8.26 (high aesthetics), 4.97 (medium aesthetics) and 2.07 (low aesthetics) and there were significant differences between the three groups. The manipulation of the usability factor had a significant effect on completion times,

with averages of 23.5 seconds per task for the high and 37.5 seconds for the low usability condition. Of this 14 seconds difference, 9 seconds were intentional delays (previously programmed on the system) and the other 5 seconds were from other causes.

Using the objective usability approach there was found no effects of aesthetics on completion times, and no interaction between aesthetics and usability which implies that the usability was distinct from any effect from aesthetics. The level of aesthetics affected both pre and post-experimental perceptions of the ATM usability.

Perhaps the most interesting findings were that the user satisfaction with the system is dependent on a combination of user's perception of aesthetics and usability rather than connected with aesthetics itself, as was initially hypothesised. However, the most surprising finding is that post-experimental perceptions of system usability were not affected by the actual usability of the system but by the interface's aesthetics.

In conclusion, aesthetics was found to be highly correlated with the apparent dimension of the system's perceived usability both before (Tractinsky, 1997) and after the interaction, as well as with user satisfaction (Tractinsky, Shoval-Katz and Ikar, 2000).

The studies described above have looked at the effect of aesthetics on perceived usability rather than actual usability and provide relevant scientific evidence of how important aesthetic aspects are and the role they play in interface design. They suggest that a new approach for interface design is no longer a matter of beauty or fashion but also usability and user satisfaction.

Hassenzahl (2003) proposes a model considering two distinctive attribute groups to describe the character of a product, pragmatic and hedonic attributes. The pragmatic attributes of a product are related to usability and the hedonic attributes are related to the product's physical attraction. The hedonic attributes were subdivided into stimulation (e.g. innovative and exciting) and identification (e.g. classy and valuable). Hassenzahl (2004) used this model to derive a questionnaire to measure different aspects of apparent product character considering the hedonic and the pragmatic attributes. He applied this questionnaire in a study using MP3 player skins and showed that these attributes are separable.

3 EMOTION AND HCI: A NEW APPROACH

The studies mentioned above suggest that aesthetics is a relevant factor for interactive interfaces. Traditional HCI (Human Computer Interface) specialists might argue that an interface needs to be usable, not beautiful. Even when they agree with the claim that aesthetics is an important aspect of the user interface it is stressed that the role of aesthetics is to be a tool to increase the information processing, not to help the user to feel more pleasure with the interface.

Donald Norman was one of the first HCI researchers to provide some evidence of the importance of enjoyability and the emotional effect the interactive interface has on us.

In his latest book, 'Emotional Design – Why we love (or hate) everyday things', Norman (2004, p.10) states that 'we now have evidence that aesthetically pleasing objects enable you to work better … products and systems that make you feel good are easier to deal with and produce a more harmonious result'. According to him, affect and cognition can be considered information processing systems

with different function and operating parameters. He describes the affective system as being 'judgmental, assigning positive and negative valence to the environment rapidly and efficiently, while the cognitive system interprets and makes sense of the world. As a result, each system affects the other: some emotions (affective states) are driven by cognition, and cognition is influenced by affect'.

Norman (2002) stated that much of human behaviour is subconscious, beneath conscious awareness. Consciousness comes late, both in evolution and also in the way the brain processes information; and many judgements have already been determined before they reach consciousness. Both affect and cognition are information-processing systems, but they have different functions. The affective system is always passing judgments, presenting us with immediate information about the world. Affect has an important role in the evolution of humans, especially in survival. Affect also impacts on how well we perform tasks. Therefore, affect regulates how we solve problem and perform tasks, and gives him support for to his famous statement: 'affect makes us smart'.

Norman (2002) states that the implication of emotion and affect for human-centred design is that people are more likely to be tolerant of minor difficulties and irrelevant problems of the interface when they are in pleasant situations. In a neutral or positive situation, any pleasure derivable from appearance or functioning of the tool increases positive affect, broadening the creativity and increasing the tolerance for minor difficulties and blockages.

'Attractive things work better... Heretical or not, it is time to have more pleasure and enjoyment in life. Although the cognitive analyses of usability and function are important, so is the affective analysis. Let the future of everyday things be ones that do their job, that are easy to use, and that provide enjoyment and pleasure... products must be affordable, functional,

> and pleasurable – and above all, a pleasure to own, a pleasure to use' (Donald Norman, 2002, p.38).

Norman (2004) believes that new scientific advances in understanding the brain and how emotion and cognition are thoroughly intertwined are helping scientists to understand how important emotion is to everyday life. He states that emotions works through neurochemicals that bathe particular brain centres and modify perception, decision making, and behaviour. These neurochemicals change the parameters of thought. This suggests a rationale for why aesthetically pleasing objects may actually work better.

Human beings have a very complex brain structure enabling various skills with greater complexity than that required for automatic responses to the environment. Modern research shows that the affective system provides critical assistance to decision-making by helping to make rapid selections between good and bad, reducing the number of things to be considered. Damasio's study (1999) shows that people without emotions are often unable to choose between alternatives that appear to be equally valid. Cognition interprets and understands the world around us, while emotions allow us to make quick decisions about it.

3.1 The levels of emotion

The studies on emotion conducted by Norman and colleagues suggest that this human attribute results from three different levels of the brain: visceral, behavioural and reflective.

The affective process starts with the visceral level, which is the automatic, prewired layer and sensitive to a very wide range of conditions. This level makes rapid judgements of what is good or bad, or safe or dangerous, sending signals

to the muscles and alerting the rest of the brain. The visceral level is for fixed routines, where the brain analyzes the world and responds.

The behavioural level relates to those brain processes that control everyday behaviour. This level is the site of most human behaviour and its action can be enhanced or inhibited by the behavioural layer, and consequently it can enhance or inhibit the visceral layer. The behavioural level is not conscious and is especially valuable for well-learned, routine operations. This is where the skilled performer excels.

The highest layer is that of reflective thought. This does not have direct access either to sensory input (visceral level) or to the control of behaviour (behavioural level). Instead, it watches over, reflects upon, and tries to bias the behavioural level. The reflective level can think about its own operations; it is the home of reflection, of conscious thoughts, of the learning of new concepts and generalizations about the world.

The state of negative affect allows a person to concentrate on a task without distraction going deeper, concentrating upon the details of the problem until some solution is reached. Focus also implies concentration upon the details, causing the behavioural and reflective levels to stop and concentrate upon the problem.

The state of positive affect broadens the brain process in order to receive any new ideas. Positive affect increases curiosity, engages creativity and makes the person into a more effective learning organism.

The two states have an impact on and are essential in the design process. Someone who is more relaxed and happy is more creative, more able to overlook and cope with minor problems with a device – 'especially if it's fun do work

with'. It makes it easier to work on a fun and enjoyable product. At the other extreme, when the person is anxious he or she is more focused, paying special attention to ensure the success of the project. It requires much more attention to details when working with products intended to be used under stressful condition.

3.2 Three levels of emotional design

Visceral design is concerned with appearance. Behavioural design deals with pleasure and effectiveness of use. Reflective design considers the rationalization and intellectualization of a product.

These three different dimensions are interrelated in any design and, despite being so different, make it impossible to have design without all three. More than that, these components interweave both emotion and cognition.

The visceral design is what nature does. The judgement of beauty comes from the visceral level, explaining the human preference for faces and bodies that are symmetrical. This presumably reflects selection of the fittest.

The principles underlying visceral design are wired in, consistent across people and cultures. Design according to these rules will always be attractive, even if it is simple. It is at this level that good graphics, cleanliness and beauty play the main role; shape and form matter. It is all about immediate emotional impact.

The behavioural design is all about use and performance. Neither appearance nor rationale counts. What matter is the focus of the usability community. The four components of good behavioural design are function, understandability, usability and physical feel, where the component function is the focus of most behavioural design. Good behavioural design focuses on understanding and satisfying the needs of the people who actually use the product.

The reflective design is very broad, involving the message, culture and meaning of the product in use. It can be about the meaning of something, the memories something evokes or it can also be related to self-image and the message the product sends to others. The essence of reflective design is all in the mind of the beholder, there is nothing practical or biological at this level, just cultural. The reflective level often determines a person's overall impression of a particular product when he or she takes time to think about the product, reflecting on its true appeal and the experience of using it. The president of the watch company, Swatch, was proud to say that their expertise was human emotion transforming the purpose of a watch from timekeeping to emotion. The company is famous for transforming a watch into a fashion object.

Attractiveness is a visceral-level phenomenon because just the surface look of the product matters. Beauty comes from the reflective level because is looks deeper into the product look. It comes from conscious reflection and experience and it is influenced by knowledge, learning and culture

Aesthetics, attractiveness and beauty come along with emotions. Norman (2002) refers to his experiment with colour monitor in the early 1980s. He was wondering why business insisted on colour monitors, at added cost, even though there were no scientific reasons to justify that. It seems that colour was fulfilling some need that could not be measured. His findings were that colour was unimportant and added no discernible value for everyday work but he 'refused to give up the colour display'.

Finally, Norman (2004) argues that 'the emotional side of the design may be more critical to a product's success than its practical elements'. His theories on emotion and affect reported by Norman (2004) will be the main foundation for

the arguments about the importance of the aesthetic aspects of design applied to VLEs, the focus of this research.

4 INTERFACE DESIGN CONCEPTS

4.1 Gestalt theory

Gestalt theory focuses on our perceptive process and has influenced many research areas since the beginning of the twentieth century, including visual design. Gestalt theory explains how the individual elements from the environment may be visually organized into fields of structure. Gestalt theorists followed the basic principles that the whole is greater than the sum of its part. Wertheimer (1924) developed a concept of pragnanz, which states that 'when things are grasped as wholes, the minimal amount of energy is exerted in thinking' (Torrans, 1999).

Nowadays their importance and relevance to user interface design is more widely accepted and understood (Ngo, Teo and Byrne, 2002). Chang, Dooley and Tuovinen (2002) claimed that Gestalt theory is one of the foundations for instructional screen design and may be used to improve educational screen design and thereby improve learning.

The laws of perception from Gestalt theory give a method for planning the presentation of graphic elements of the interface in order to help users learn in a more effective and enjoyable way. These laws explain how individuals perceive and organize their auditory and visual fields, being particularly relevant for Virtual Learning Environments (VLEs). The users of a VLE are exposed to screen information which is supposed to help them learn, or even better, learn more efficiently and in a more pleasing environment.

According to Koffka (1935) visual fields are organized into visual patterns that are grouped according to the laws of perception, which involve: figure-ground, proximity, similarity.

Chang, Dooley and Tuovinen (2002) identified eleven distinct laws that represent the major aspects of Gestalt theory about visual form, which seemed to contain the most relevant aspects for computer screen design. Their laws are the following: Balance and Symmetry, Continuation, Closure, Figure-Ground, Focal Point, Good Form, Proximity, Similarity, Simplicity, Unity and Harmony. They conducted a study to examine the benefits of using these Gestalt laws in the redesign of a multimedia application. The study showed that the participants enjoy the new screen design more and that they could recognize the value of Gestalt laws for visual interface design as well as for their own learning from multimedia design using its principles.

Ngo, Teo and Byrne (2003) proposed a theoretical approach to capture the essence of artists' insights with 14 aesthetic measures for graphic displays based on Arnheim (1974) and Dondis (1973) and from the literature on screen design in Galitz (1985). Therefore they presented a computational theory of evaluating interface aesthetics to discover the principal determinants of the aesthetic evaluation of the interface.

Based on these principles, Ngo, Teo and Byrne (2004) developed 14 aesthetic measures (balance, equilibrium, symmetry, sequence, cohesion, unity, proportion, simplicity, density, regularity, economy, homogeneity, rhythm, and order and complexity) for graphic displays. Their empirical study suggested that these measures may help gain attention and build confidence in using a computer system. Table 3.1 shows how these 14 aesthetic measures were combined together in order to be used in this research.

Table 3.1: The combination of 14 aesthetic measures in five principles.

Principle used	Principle combined
Unity	Order and complexity
Proportion	Density Economy
Homogeneity	Cohesion Simplicity
Rhythm	Sequence Regularity
Balance	Equilibrium Symmetry

For the purpose of this research, the 14 aesthetic measures of Ngo, Teo and Byrne (2004) and the 11 laws for computer screen design (derived from Gestalt) Chang, Dooley and Tuovinen (2002) have been combined with relevant design principles that are most accepted by the designers' community and widely used for the development of their practical work. The result was summarized in five design principles (unity, proportion, homogeneity, balance and rhythm), which seem to be the most relevant and suitable for the particular needs of a screen layout of a computer interface for Virtual Learning Environments.

One of the reasons artists commonly embrace Gestalt theory is because it provides, in their minds, scientific validation of age-old principles of composition and page layout. (Behrens, undated).

4.2 Design principles

- **Unity**

Unity is coherence, and refers to the extent to which a group of visual elements are perceived as all in one piece. Unity, by definition, is the extent to which the screen elements seem to belong together so completely that they are seen as one thing. Unity can be achieved by grouping, repeating or placing elements on a grid (Ngo, Teo and Byrne, 2003).

In Figure 3.1 (a) unity is achieved by leaving less space between elements of a screen than the space left at the margins so that the elements are grouped together and surrounded by white spaces while in (b) the items look as if they are ready to move out from the screen.

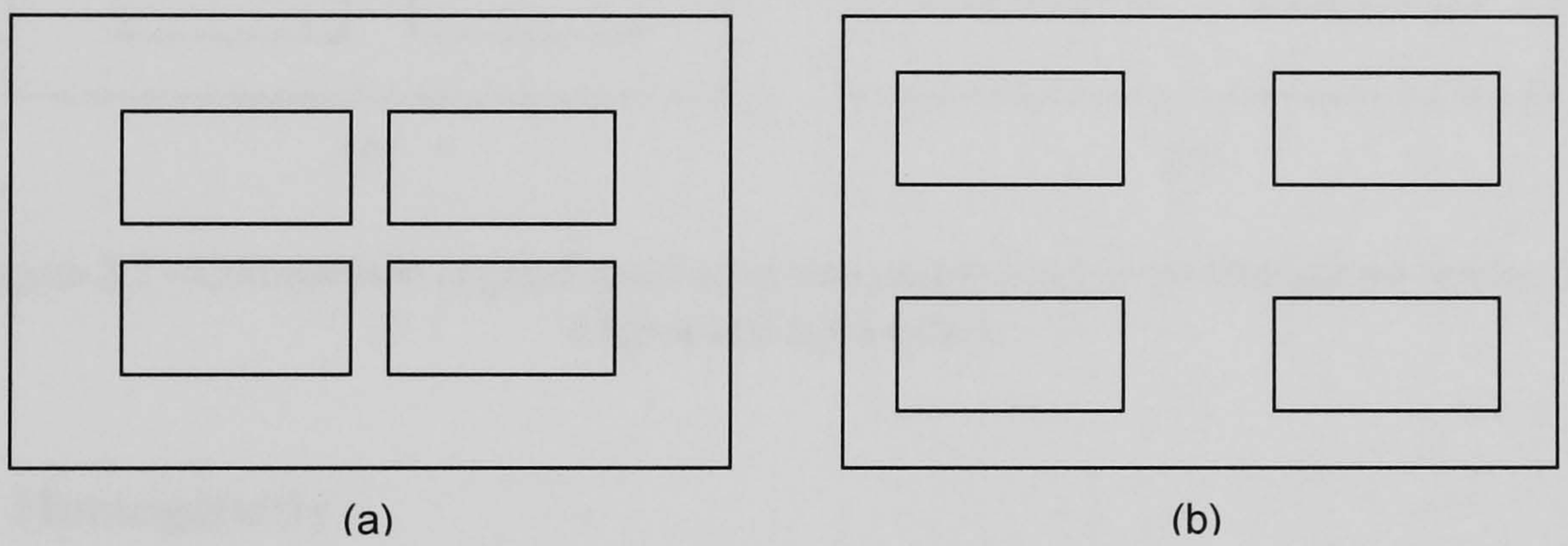

Figure 3.1 – Comparison of good and bad screen unity: (a) unified screen; (b) fragmented screen.

- **Proportion**

Proportion is defined as the comparative relationship between the dimensions of the screen components and proportional shapes. In screen design, aesthetically pleasing proportions should be considered for major components of the screen, including windows and groups of data and text.

Aaron Marcus (1992) describes five shapes as aesthetically pleasing – square (1:1), square root of two (1:1.414), golden rectangle (1:1.618), square root of three (1:1.732), double square (1:2). These shapes have stood the test of time and cultures and are found in abundance today and will be used for developing stimuli material for our own the experiments.

In Figure 3.2 (a) proportion is achieved by creating objects with aesthetically pleasing proportion and close approximations to the proportional rectangles described by Marcus (1992). These proportions cannot be recognized in (b).

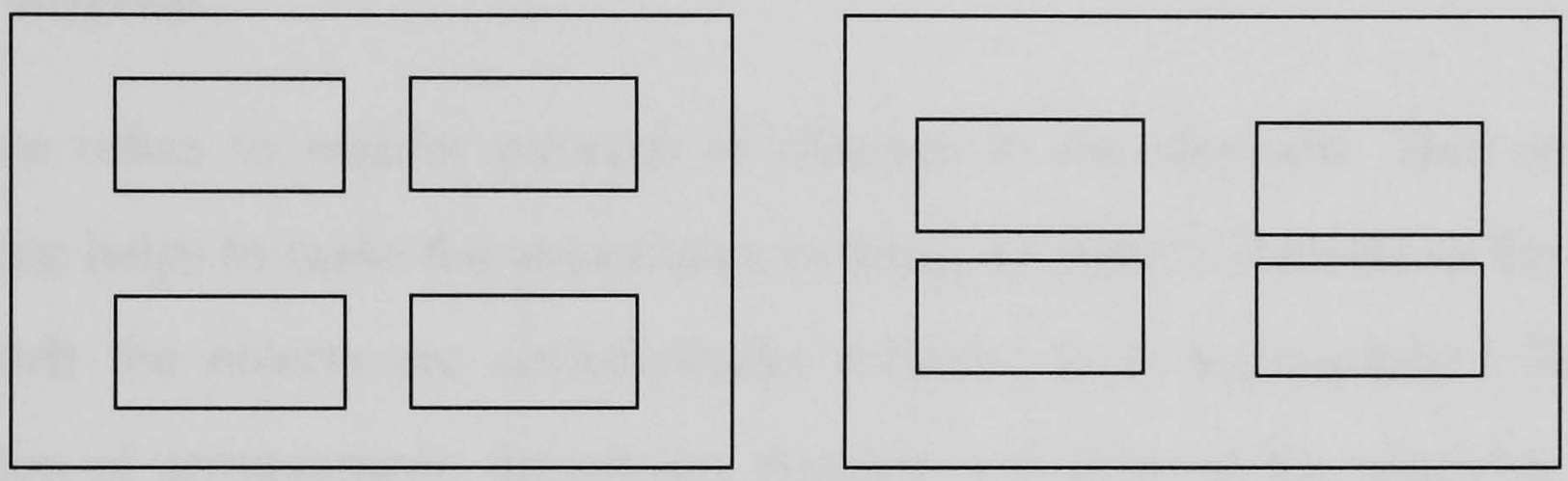

Figure 3.2 – Comparison of good and bad screen proportion: (a) proportionate screen; (b) disproportionate screen.

- **Homogeneity**

Homogeneity is defined as a measure of how consistently the content is shown and the objects are distributed throughout the screen. The relative degree of homogeneity of a composition is determined by how evenly the content and the objects are distributed among the four quadrants of the screen (Ngo, Teo and Byrne, 2003). In Figure 3.3 (a) the objects are distributed evenly among the four quadrants of the screen while (b) are not.

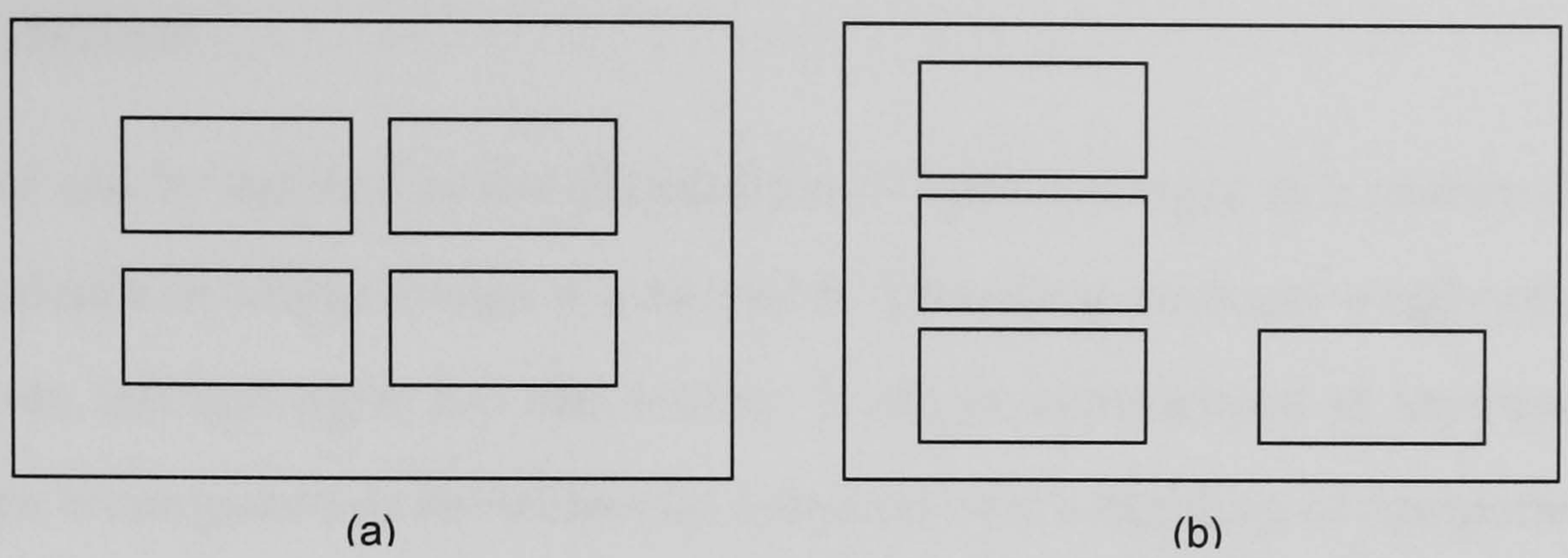

Figure 3.3 – Comparison of good and bad screen homogeneity: (a) homogeneous screen; (b) uneven screen.

- **Rhythm**

Rhythm refers to regular patterns of changes in the elements. This order of variation helps to make the appearance exciting. Rhythm is defined as the extent to which the objects are systematically ordered. It is accomplished through variation of arrangement, dimension, number and form of the elements (Ngo, Teo and Byrne, 2003). In Figure 3.4 (a) rhythm is achieved through systematic ordering while in (b) the elements have a confusing appearance.

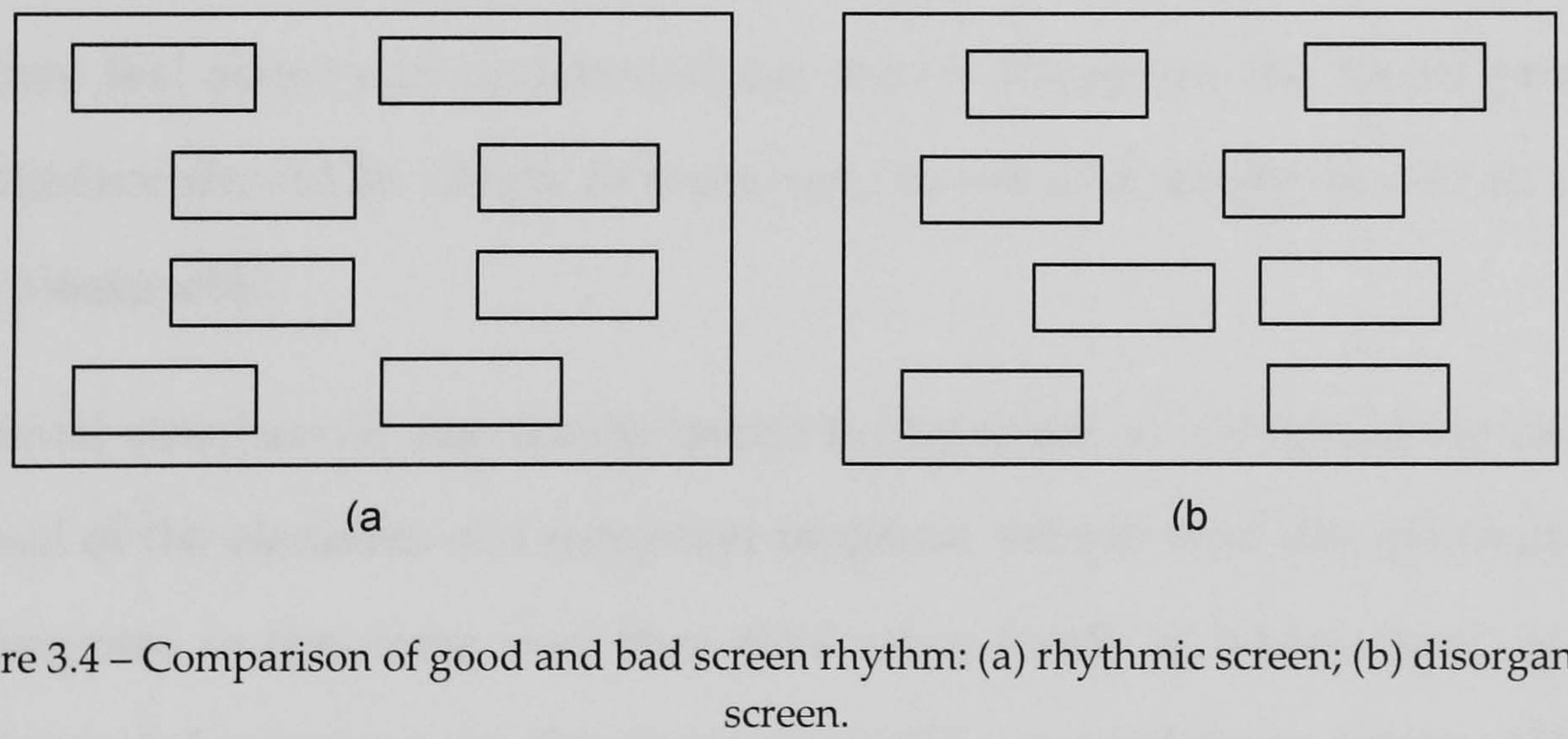

Figure 3.4 – Comparison of good and bad screen rhythm: (a) rhythmic screen; (b) disorganized screen.

- **Balance**

Balance can be defined as the distribution of optical weight in a picture (Figure 3.5). Balance in screen design is achieved by providing an equal weight of screen elements, left and right, top and bottom. It can be symmetrical or asymmetrical. Balance is computed as the difference between total weighting of components on each side of the horizontal and vertical axis (Ngo, Teo and Byrne, 2003).

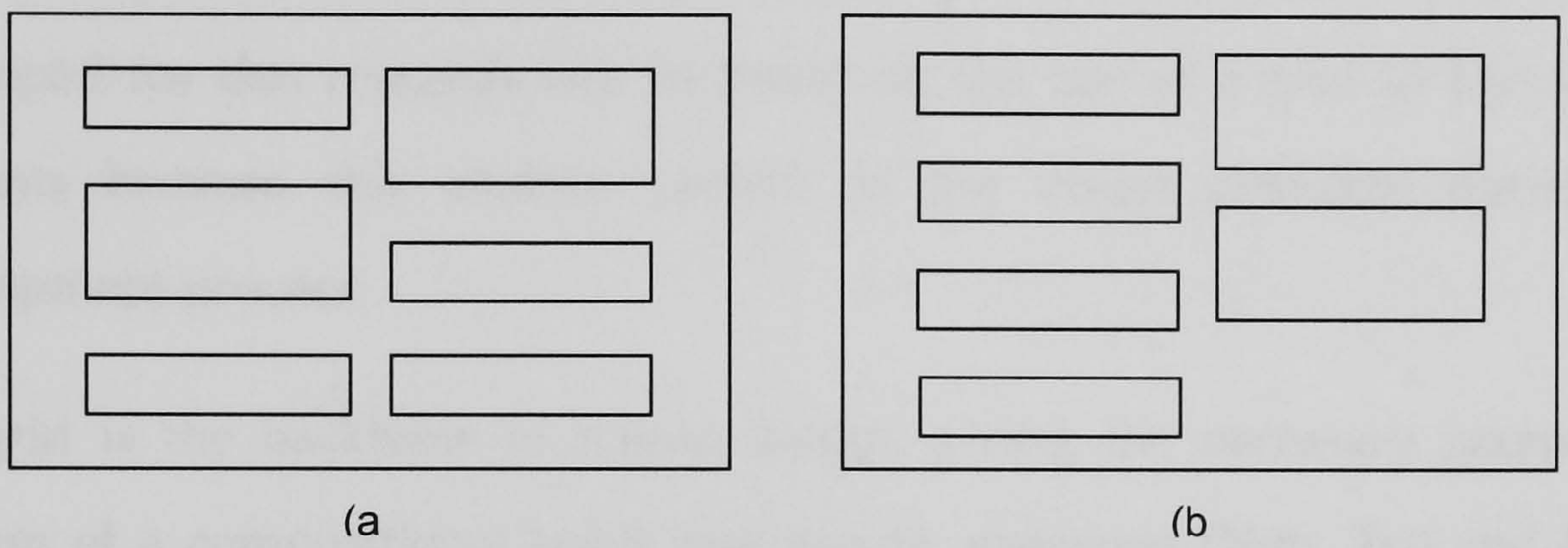

Figure 3.5 – Comparison of good and bad screen balance: (a) balanced screen; (b) unbalanced screen.

These principles are important because visual information can include emotional factors that motivate, engage and please the user. What people see influences the way they feel about and understand the world. Therefore, the visual project of any interface should be simple to learn, easy to use and satisfy its user as well as being pleasurable.

The visual structure of any screen layout is important to communicate the main proposal of the elements of a computer interface. People read the information on the computer in the same way they read other kinds of information, spatially organizing it by groups. In the Western world we read from left to right and from top to bottom. So, it is better to propose a layout where the information is grouped by different kinds of information. It is necessary to be careful of the placement of the information so that the interface environment can be visually

consistent and predictable. After all, the main goal is to create an interface where the user can work intuitively – it needs to look the way it works and it needs to work the way it looks.

5 LAYOUT COMPOSITION

The layout defines the way designers set up a composition, how and where they set the visual elements on a compositional space. The interfaces that will be developed for this research will be based on the use of a grid to lay out the elements because this enables control of the visual elements during the development process.

The grid is the backbone of screen design, giving the necessary geometrical division of a compositional space into precise measures (Ngo, Teo and Byrne, 2003). It also assists designers in creating good composition (Waters, 1996).

Waters in his book Web Concept & Design (1996) mentions that grids help to blend the linear formality of type with the flow of photography or illustration and they guide a viewer's eye through a page.

Jute (1996) states that the primary purpose of the grid is to create order out of chaos; it is an aid to readability, recognition, and understanding. Creating grids for use during the planning phase of a project saves time and helps ensure unity and homogeneity throughout the project. For example, the use of a grid to develop a webpage ensures that similar types of pages have a similar look and feel.

Composing and designing spaces using grids has become a useful, or even more, an essential, tool for the practising designer of any type of graphical design.

A recent study by Ch'ng and Ngo (2003) on the use of grids and guides by 30 inexperienced users showed that 23 found them useful. They related that interface design without grids is a difficult task. In the same study, more than 53% of the participants used a grid for interface layout assistance with symmetry, balance, alignment and positioning the elements. A number of them made use of the grid to achieve beauty, flow of design and harmony.

Jay Hambidge (1926) has developed a technique termed 'Dynamic Symmetry' based on the use of the golden section and root rectangles used in ancient Greek design. The origin of this proportioning system uses the proportions taken from the human figure, the growing plant, and the logarithmic spiral curves of shells as its fundamental design principles.

This technique applies to dynamic rectangles (square, root-2, root-3, root-5 and double square) and forms a pattern where only certain rectangles of the same theme co-exist.

The properties of dynamic symmetry are very suitable for screen design of various characteristics as the thematic attributes (i.e. any dynamic rectangle forms a pattern where only certain rectangles of the same theme co-exist) remain the same for all of the proportions. The conception of thematic proportion in a composition is the unique aspect of dynamic symmetry not found in other modular systems. According to received design practice, this characteristic can create unity and homogeneity, the pleasing interaction of parts in the screen composition and 'the recurrence of the same proportion in the elements of the whole' (Ghyka, 1952).

The technique consists of the tracing of diagonals and perpendicular to diagonals, on a dynamic rectangle. For design purposes, the diagonal is the most

important element of a rectangle followed by its perpendicular. An example of grid generation in a rectangle is shown in figure 3.6.

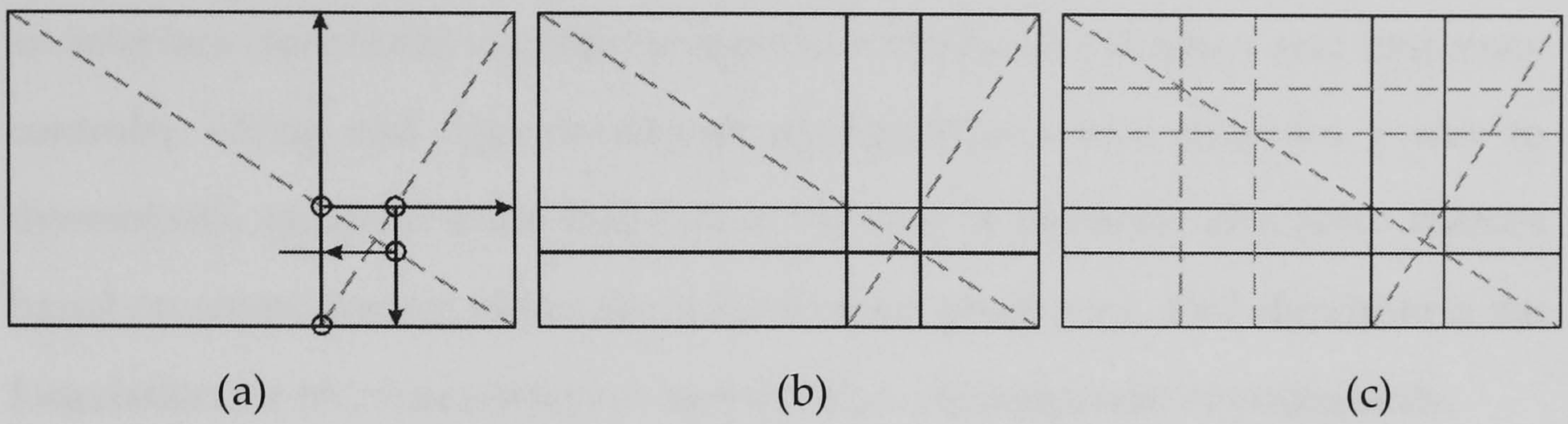

Figure 3.6 – Sequence of grid generation. (a) the process of drawing gridlines form the perpendicular diagonals; (b) the completed gridlines; (c) the gridlines mirrored to complete the process.

This notion of a relationship between the proportions of rectangles derives its importance from a law of composition; the law of the non-mixing of proportions or themes in a single composition (e.g. in a composition only related themes must be used and antagonistic themes must be avoided).

In a more recent technical report Ngo and Ch'ng (2003) discovered that dynamic symmetry was unconsciously used by experienced designers, whose sense of aesthetics is highly developed. The goal of the study was to find whether the dynamic symmetry has been applied in the past. Out of the many examples of screen design that could be analyzed in accordance with the principles of dynamic symmetry, 75% show dynamic schemes based on Hambidge's technique. The result was quite surprising due to the fact that the designers were not aware of dynamic symmetry, suggesting that designers have been using dynamic symmetry for a long time. It seems that the laws of proportion are somehow inherent in visual perception, even though it is difficult to define what makes the design pleasing.

Ch'ng and Ngo (2003) developed an automated Dynamic Symmetry Grid System (DSGS) based on manually designing screens with dynamic symmetry and Dix et al. (1998)'s advice on the three possible organizations of the controls in designing an interface (functional controls, sequential controls and displays and frequency controls). Ch'ng and Ngo developed an algorithm which provides a way to dynamically generate grids that follow the law of dynamic symmetry themes based on screen frames, object shapes and object placement. This algorithm is the foundation for implementation in user interface development environments.

The experiment, using the automated DSGS, was carried out by Ch'ng and Ngo who asked four participants to design a screen by placing 5 elements in the position they liked best. They were allowed to change scale, size and move the objects. When they finished the participants requested the system to automatically reposition and reshape the objects according to the dynamic grids. Each set of screens, original and reformatted by the system, were placed side-by-side in random order on an intranet voting system for this purpose. The result suggests that screens reformatted by the system are generally better (mean = 67.86%) than a non-structured approach without the grids.

6 USE OF DESIGN PRINCIPLES

6.1 Web pages

Ngo, Teo and Byrne (2003) proposed fourteen aesthetic measures for graphic display layout as a theoretical approach to capture the essence of artists' insights. They presented a computational theory for evaluating interface aesthetics as a way of objectively defining and measuring these aesthetic qualities of displays. Their empirical studies suggested that these aesthetic measures are important to

potential users and may help gain attention and confidence in using computer systems.

Ngo, Teo and Byrne carried out some experimental studies using aesthetic measures for screen layout design as a way to improve users' attention and confidence in using computer systems. Their main interest was in multi-screen interfaces which may contain any combination of text, graphics and image items with focus on the perception of the structure created.

They performed a study to validate their proposed measures using a set of real screens. In the first part of the study they wanted to establish aesthetic values for the screen using their measures for comparison with viewers' ratings of the layouts and to see how consistent they were.

In the second part they examined viewer judgements about the aesthetics of these layouts. The five design layouts on grey scale transparencies were displayed in a large classroom using an overhead screen projector for about 20 seconds. During that time the participants rated each layout on a low – medium – high scale regarding how beautiful it was.

The results show that the relative ratings by the viewers are consistent with the ones obtained with the proposed computational measures, which suggests that their model is somewhat related to the viewers' perceptions of aesthetics.

7 CONCLUSION

This research investigates the role that aesthetics plays in the perceived usability of computer interfaces focusing Virtual Learning Environments (VLEs). Both, aesthetics applied to computer interface and VLEs are new areas being investigated.

The pragmatic part deals with the use of technology (apart form pedagogy, etc.) used to develop the interface, its benefits, and ways of using VLEs.

Virtual Learning Environments are the latest technology tool developed for distance education. They make use of the Information Communication and Technology to deliver online courses in a variety of ways that go from an extension of face-to-face lectures to an entirely online course with the students being geographically separated, without any face-to-face meetings or contact among students.

Nowadays, they are widely used in many countries to deliver different levels (e.g. higher and further education), different modalities of courses (e.g. training, certificates as well as diploma) offering the opportunity of flexible learning for those who, otherwise, could not attend the courses, among a number of other advantages. Embarking on a course delivered through VLEs offers many benefits (e.g. study at his or her own pace and time, from home, etc). However, the lack of human contact still brings a little resistance from the students.

There are many environments, commercial or made on demand, already being used with successful feedback from the students and tutors. Most of them offer similar type of features (e.g. material delivery, communication tools, course management, etc.). Different environments suit different courses, learning styles or educational theories. However the main interest of this research is about how their interface can become more motivating, engaging and pleasant to the users.

A second strand of the research is concerned with the use of aesthetics. This is a truly ancient subject that motivates civilizations to create works of art that reveal its importance and power. Modern researchers still hold out the hope that they will find the underlying principles of art and design.

Aesthetics is part of the human concern. It was not forgotten by the modern architects and artists; instead it gained more and more attention among them to create the most important pieces of art work known today, such as: Phaternon, and most of the work of renowned artists and inventors such as Leonardo da Vinci.

There are some theories intended to reveal how to achieve aesthetics. Though they have different names, most of them are interrelated in one way or the other, such as: the golden rectangle or golden number (0.618), closely related to the Fibbonacci series (1, 2, 3, 5 ,8 ,13…) with both being based on the grownth of living organisms (flowers, plants, human body, small animals, etc.). Hambidge's technique of dynamic symmetry also uses rectangles derived from the previous concept with the difference that it used the rectangle diagonal and its perpendicular to generate the grid that is the backbone of the layout composition. The Gestalt laws of perception give the fundamentals of design by exploring the users' perceptions of how the whole is interpreted by the brain.

Some researchers are starting to apply them to graphical computer interfaces to achieve an organized visual composition of the screen layout. Others go even further, suggesting that aesthetics has a bigger impact on computer interfaces than we can ever imagine.

Norman (2004) draws on scientific research from the human brain and how it processes information to give evidence of the role that aesthetics plays in artefacts design. His new look on how we use products resulted in a theory on emotional design suggesting that the three levels of design are related to the levels of the human brain processing information: the visceral level, which is just about appearance and is automatically activated by the brain (therefore, it is not culturally dependent); the behavioural level, which is about effectiveness of use

and controls everyday behaviour; and the reflective level, which is about personal satisfaction and self-image. At this stage, the design becomes culturally dependent.

This research wishes to corroborate the thesis that aesthetics is an important factor in interface design. So, it will focus on the aesthetic aspects of VLEs in order to achieve not just usability, but beauty to awake the users' emotions and affect.

It will consider the researchers' findings and their proposed thesis outlined in this review (e.g. Tractinsky; Ngo, Teo and Byrne and Chang, Dooley and Tuovinen, etc.) to develop a model, based on experimental work, that could help provide the users with more pleasing VLEs, which they enjoy interacting with during the not-so-easy learning process.

PART II

Observational study

Chapter 4

Study on VLE communication tools

1 INTRODUCTION

This pilot study intends to investigate how participants in online courses use collaborative tools to communicate with each other in order to support online learning using Virtual Learning Environments. This is an observational study and is not to test any specific hypothesis.

For this pilot study, the researcher participated in a Project Management module. This elective module was eight weeks long, with two hours of lectures per week, and it was part of an MSc course. Participants were geographically distributed, with the tutor based in England, while the students were based in Germany, Sweden and Nigeria.

In order to evaluate the use of the collaborative tools this pilot study utilized two questionnaires and one diary. The first questionnaire was completed at the beginning of the module, the diary during the development of the module and the second questionnaire at the end of the module.

This field study used observational analysis and log records for the collection of qualitative data during lectures.

2 OVERVIEW OF THE ENVIRONMENT

The environment used to deliver this module was called LearnLinc™ (live e-learning from Mentergy). This state-of-the-art environment allows

synchronous, sound and video at the same time, and asynchronous communication.

'LearnLinc™ is a real-time, online environment that enables corporations and universities to deliver live e-learning courseware to employees or students via the Internet, corporate or university intranet, or wide area network.' (Mentergy, 2005, p. 07)

The environment allows the instructor to deliver lectures using audio conferencing. The classroom software contains many collaborative tools such as two-way audio conferencing, hand raising, floor control, application sharing, record and playback.

These features and tools allow the students to interact and collaborate during lectures. Students can raise their hand and the tutor can pass the floor to them. Whenever a student holds the floor, he or she can speak and be heard by the others. It also allows students to share documents because other students see the floor holder's desktop, so he or she can point out things (on his or her own computer) to explain something to the others.

Students can see a picture (or avatar) of the instructor (Figure 4.1 – a) or of other students during the time they hold the floor. They can also see the names of students who have already joined the lecture (Figure 4.1 – b) as well as the agenda for that specific topic (Figure 4.1 – c).

Another feature of the environment allows the tutor to ask for students' feedback to check if there were any doubts about what he was explaining. This feedback gives the tutor an instant answer and helps him to conduct the lecture. He can also use an online quiz to verify students' understanding about a specific topic (Figure 4.1 – d).

Students also have a text chat facility to communicate with other students during lectures (Figure 4.1 – e). This can be public, so that everyone can see, or private, where only the tutor or technical support can see. The text chat also allows the students to answer questions from the tutor.

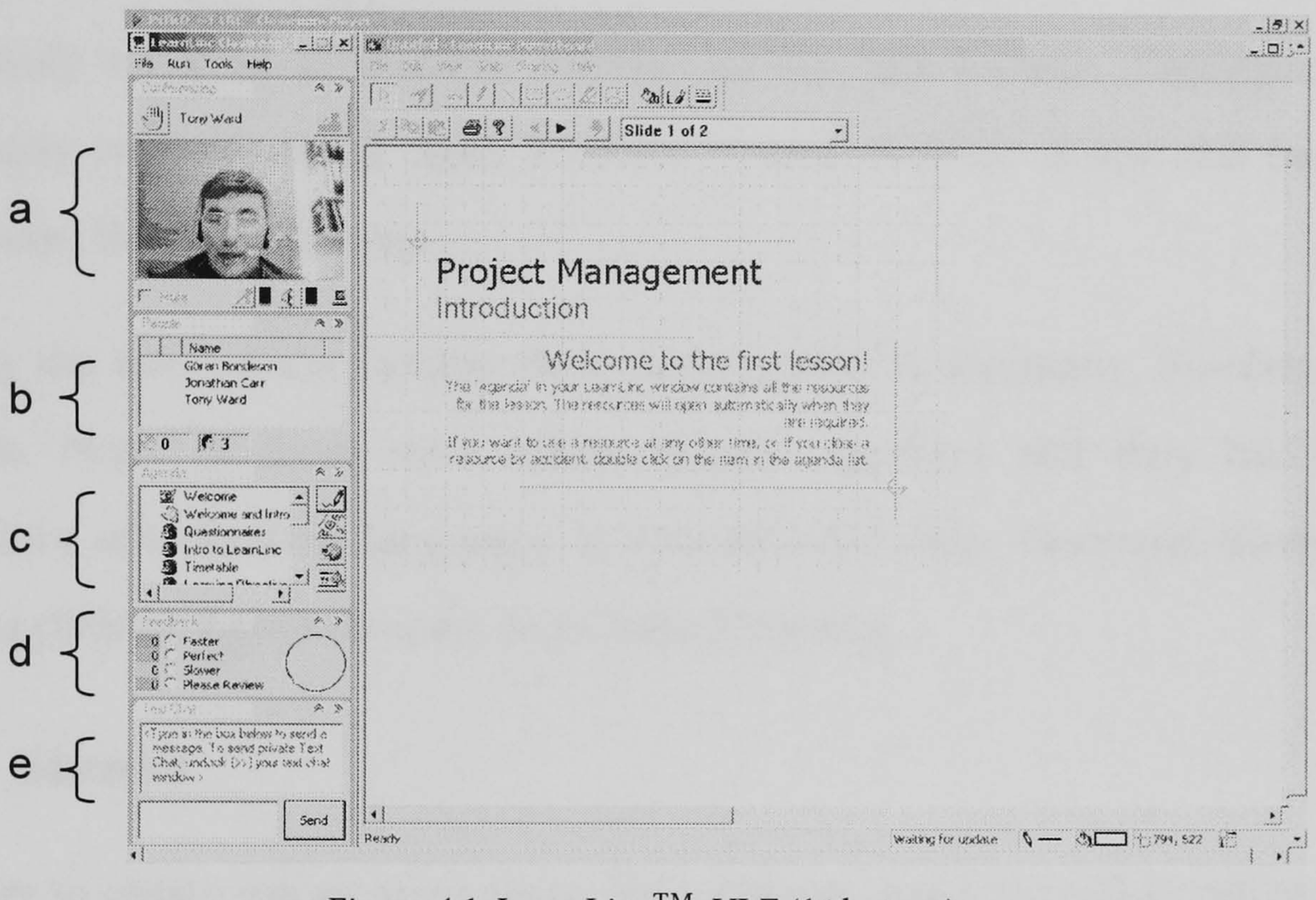

Figure 4.1: LearnLinc™ VLE (1st lecture).

Students who could not join the lectures synchronously have the possibility of studying using the recordings, which allow them to see and hear what happened during the lectures. This facility also helps the students to review the lectures or specific topics.

The Project Management module started at the beginning of May 2003 and finished at the beginning of July 2003. Nine lectures were scheduled on a weekly basis however, one had to be cancelled. The lectures took place at night (GMT) because of the students' availability to take part in synchronous lectures.

The lectures were two hours long. At the beginning of the lectures, the tutor first welcomed everyone joining the lecture, gave a brief introduction about the

topics to be covered on that day, dealt with minor technical problems and then started the lecture.

2.1 Method

2.1.1 Participants

This study involved 17 students enrolled on this MSc module. Participants of this study were all males, aged between 20 and 39 years of age and most of them were living on campus.

During the time of the lectures they were located in Germany, Sweden, and Nigeria. None of them were native English speakers and they had their secondary schools (first language) in Tanzania (Swahili), Germany (German), Nigeria (Ibibio), Egypt (French) and China (Chinese).

2.1.2 Material

In order to obtain information about how students used the collaborative tools the pilot study used two questionnaires and one diary, both of them to be completed on the Web, together with the course material. The researcher also attended the lectures in order to make an observational analysis of students' behaviour when using a Virtual Learning Environment.

Students were first informed about the research by the tutor at their first lecture. They then received the letter of information explaining the aims of the study. The participation in this study was voluntary and the students were not rewarded for their participation. In addition, they had the right to withdraw at any time during the study.

The letter of information and consent form were also on the web. Students consent, questionnaires and the diary were sent back, as an email, directly to the author.

The first questionnaire comprised two sections. The first section was about the participant, his or her knowledge of the English language, experience of and expectations about the Virtual Learning Environment itself and reasons for participating in the online module. The second section intended to gather information about the participant's preparedness for using a VLE, such as confidence, enjoyment and motivation for using an online environment and its collaboration tools.

The second questionnaire intended to evaluate the students' experiences during the Project Management module. It focused on students' awareness of self, concerning their enjoyment, involvement, attention, collaboration and interaction using the collaborative tools like email, the discussion board, chat and video conferencing.

The questionnaires were based on the Monk and Watts awareness questionnaire[1] and the SOLE[2] project questionnaire.

Monk and Watts developed a questionnaire with a positive and a negative question for each of the investigated items. In order to interpret the results from each item it was necessary to transform the negative answer into a positive one. They believed that in this way participants would have to really read each question in order to answer it, they could not choose an arbitrary answer. In other words, this design seems to balance out the effects of the response bias.

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[1] Personal communication between the researcher and David Grayson that used the questionnaire on an experiment about peripheral participation in remote communication (2002).

[2] The SOLE (Students' Online Learning Experiences) evaluation project was a national project in UK looking at success factors in the use of Virtual Learning Environments (2003).

The students were also asked to complete a short diary whenever they used the LearnLinc™ environment to do something related with the Project Management module. The purpose of the diary was to look at how the students would use the collaborative tools on a daily or weekly basis. The main reason for asking the students to complete this was to find out how useful the tools were for them and how successful the outcome of a specific task was.

The questionnaires and the diary were available on the module website. The first questionnaire and the diary were made available for them to complete after the first lecture. The end of the module questionnaire was made available two weeks before the end of the module. There was, on the module website, an explanation about the research study. The tutor also told them about it and asked them to complete the questionnaire.

2.2 Procedure

First, the students were asked to read the information letter and consent form. If they agreed to participate in the research, they were required to click on a button 'I accept' to indicate so.

In order to participate in this observational study students had to fill in two questionnaires and a diary.

The questionnaires were made available on the Web and students would take approximately ten minutes to read and complete each of them. The diary was also on the Web and the student would take no more than five minutes to complete it. No payment was offered for their collaboration because they were already part of a bigger experiment within the Genius Project (http://www.genius.rdg.ac.uk/). The Genius consortium consists of nine universities across EU, four major IT companies, e-Skills and ICEL Ltd,

Belgium. This is a truly public-private partnership based on the joint work of all the parties within the Career Space consortium. The Genius project focus on investigation of different innovative instruction/content delivery mechanisms, corresponding to the new pedagogical paradigms based on the new ICT Curricula and e-learning platforms of the partners.

The first questionnaire was to be completed at the beginning of the module and it comprised two sections. The first section consisted of multiple-choice questions and some open questions to explain their choice. The second section, on the other hand, consisted of questions to be answered using a 5-point Likert scale, where: Strongly disagree = 1, Disagree = 2, Neither agree or disagree = 3, Agree = 4 and Strongly agree = 5.

The second questionnaire was intended to be completed at the end of the module. All questions on the second questionnaire were to be answered using the same Likert scale used in the second section of the first questionnaire

During the development of the module students were also asked to complete a short Diary whenever they used the LearnLinc™ environment to do something related to the Project Management module. The diary used multiple choice questions and open questions to add any comments about their answers.

The documents used in this pilot study are shown in Appendix 1.

3 RESULTS

This observational study was intended to give the researcher an overview of the real problems when dealing with communication among the participants of an online module in order to achieve collaboration using Virtual Learning Environments.

There were, especially in the first five lectures, a significant number of requests for the floor and this showed the students were comfortable with the environment and motivated by the lecture to ask questions and add comments.

3.1 Questionnaires responses

The data gathered from the questionnaires was intended to be analysed quantitatively. However, in the event, only five respondents completed the first questionnaire. The answers about their identification had shown that they were all participants from outside the UK, living on campus and did not have English as their first language.

Although English was not the participants' first language, their self-reported confidence with English was very good, especially with reading (mean 4.8) and listening (mean 4.6). Writing, talking and general understanding had the same mean (4.4). The means were based on a 5-point Likert scale.

The other questions from the first part of the questionnaire were related to general issues concerning the use of VLEs. The answers were as follows:

Using VLE

- four out of five of them had never used a VLE before and one reported having used a VLE and that the experience was very good.

Concerns about using VLE

- two of them didn't have any concerns about using a VLE and the other three gave the following answers:

'Not familiar with this tool';

'Sometimes I have problems because of the many user names and passwords. There is no direct way to reach what we need 'easily' (sic)';

'For now I do not have a microphone or a headset (only loudspeakers). I wonder if I need 'one' (sic)'.

Aspects of using VLE that they are looking forward to

- three of them were not looking forward to any particular aspects of using LearnLinc™, one did not answer and the other gave the following answer:

  'Learn something about virtual project management'.

Aspects of using VLE that they are not looking forward to

- three answered negatively when asked if there was any aspects that they were not looking forward about using LearnLinc™, one did not answer and one stated the following:

  'Problems with the technique on my not so up-to-date pc'.

The reasons to participate in this online module

- two answers: 'I don't have time to attend face-to-face modules';
- two answers: 'It's not available at the institution where I am currently studying';
- three answers: 'I want to try new technologies';
- one answer: 'I work part time';
- one answer: 'I always get information about online course but 'I have never tried' (sic) it before'.

The last part of the first questionnaire was investigating their learning experience (preparedness) to study using a Virtual Learning Environment. Questions were related to their confidence with the Internet (media) and with

the subject, their motivation about online classes, their enjoyment of participating in online discussions and working in groups and their prior use of collaboration tools like email, chat, discussion board. There were just four participants who answered the questions related with the discussion board and chat; this response rate was so low that a quantitative analysis is not really interpretable. They are included here for completeness.

All the answers were based on a 5-point Likert scale where: Strongly disagree = 1, Disagree = 2, Neither agree or disagree = 3, Agree = 4 and Strongly agree = 5. The data from the questionnaires are shown in Tables 1 and 2.

Table 4.1: Mean rating and standard deviation for questions on preparedness to study using VLE.

	Confidence with the Internet	Confidence with the subject	Motivation to use online classes	Participation in online discussion	Enjoy working in groups
mean	3.9	4.4	3.3	3.2	3.2
stdev	1.024	0.418	0.836	0.57	1.036

Table 4.2: Mean rating and standard deviation for questions on the use of communication tools.

	Like to use email	Like to use chat	Like to use the discussion board
mean	4.5	3.6	4.1
stdev	0.866	0.946	0.853

The last questionnaire was intended to evaluate their personal awareness. The questions were related with enjoyment, involvement, attention, collaboration, discussion and interaction. No completed questionnaires were received from the end of the module questionnaire. The reason may be that the last lecture, called 'test lesson', never took place.

The diaries were intended to show how much the students used the communication tools and for what purpose. No completed diaries were received during the period of time that the module lasted.

3.2 The observational analysis

The lectures were designed to take two hours. Despite that, the tutor and the students would negotiate to stay longer or finish the lecture before time. On two occasions the tutor asked if everyone agreed to stay a little longer (e.g. 15 minutes) to finish that particular topic. On another occasion, where the content of the lecture was very theoretical, one student asked to end the lecture before finishing the content because he couldn't cope with the topic for longer. He was feeling very tired. In both situations they reached an easy agreement, showing good team work. Text chat was recorded from four out of the six lectures (two recordings were lost and some finished a little before the end of the lecture).

Interaction among participants on text chat was useful for the participants during the lectures. An indicator of this was that the chat facility was used in different communication categories, such as question, response, comment, technical as well as social.

The floor facility showed a unique way of participating in the lectures. It was used as a way to answer questions, which the tutor did using the audio facility.

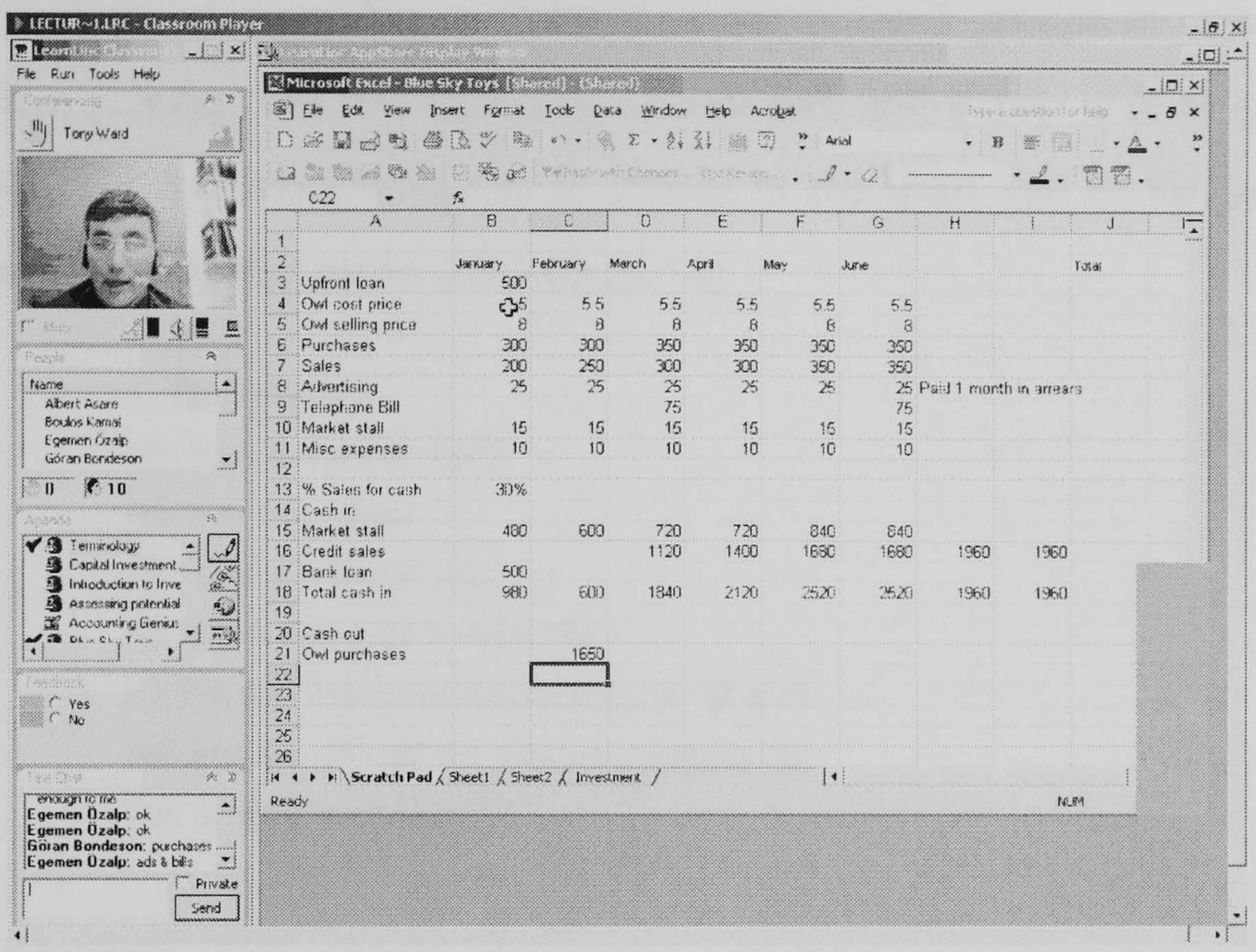


Figure 4.2 shows the screen of one of the participants as he was controlling the floor in order to illustrate and answer the question put by the tutor.

Figure 4.2: Example of one lecture.

During the lectures, the text chat facility was very useful for the interaction among tutor and students (e.g. the tutor would propose, as part of the lecture, an interactive brainstorm in order to give ideas about how to deal with a particular financial situation and the students would answer using the text chat). (Transcript 4.1)

… GB: raise the loan

IU: get a larger capital

GB: Shorten customer credit time

EO: postpone purchase for 1 month

GB: Higher sales price

BK: Decrease the number of purchased items .

GB: Longer credit time from supplier …

The students also use the text chat to work in small groups in exercises of problem solving. The text chat had a small area and it was easy to loose the initial idea. An example of this is shown in the third line of the following transcript '…say that again' (Transcript 4.2)

… EO: bankrupt

AA: high not worth doing

AA: say that again

GB: Common bank rate

AA: there tables of interest rates

IU: the one that gives positive npv for all projs

AA: and we can get the most appropriate rate

GB: Internal calculated IR" …

The third transcript was part of an exercise called 'the great bank robbery' and shows an example of how the students used the chat facility. It can be observed that the students would divide their thoughts into two parts, so that the others students would not wait a long time. (Transcript 4.3)

… JC: i calculate 6mins 15 secs from triggering alarm to driving away

AA: super

BK: i think it should be 6 mins 45 seconds till get outside the passage ...

BK: 45 secs from the rear door

LH: 6min45 sec

BK: 60 sec

BK: if we r leaving from the front

EO: yes.

AA: not to give the counter staff the chance to set off the alarm

EO: yes

AA: duation of second group not total time

LH: ok

BK: Escuse me but it will be 4 mins only not 4 mins 30 secs. …

They also use it to sort out some disagreements about the group formation for the final assessment. It is possible to see in this transcript that the students adapt their way of expressing ideas according to the media. It shows a student writing in chunks so that the teacher would follow his idea without waiting long. In this case the student used 33 entries to express his idea. (Transcript 4.4)

EO: Tony can i ask a question?

EO: can u hear me?

EO: ok

EO: my question is

EO: ok

EO:: in teams

EO: especially about team member relations

EO: it is a fact that everybody does not work in the same level

EO: mostly because of background & interests

EO: in my previous job & still i have the same problem as treating the same

EO: to all members

EO: how should this be mentioned and communicated?

EO: am i clear?

Tutor: Not sure I fully understand - what do you mean by level please?

EO: the problem is important especially it also affects the team soul... rather than staying as a personal problem

EO: for example; some members are not suitable for that project

GB: ok

EO: so they cannot work efficiently

EO: not only personality but also their background

EO: i did not hear well

Tutor: How would background manifest itself other than through behaviours?

EO: ok,

EO: my main aim is, let me give example

EO: for ex, we are engineers

EO: and most of our backgrounds are different; Electrical, Electronics or Computer...

EO: somehow related but different

EO: and in a team we have to finish a project

EO: but the team is organized wrongly by the leaders at first sight

EO: so how can this be managed to change or review the team members?

EO: without disturbing the team soul...

Tutor: Interesting question - I am thinking

EO: ok, thank you :)

EO: maybe i should e-mailed this instead of asking here...

Tutor: OK - that would give me more time to think it through

EO: ok then...

EO: good night

Tutor: Perhaps yes - email it to me, perhaps we could use it as the basis of a group disussion?

EO: and thanks a lot …

The text chat was also very useful to solve technical problems that would occur during the lectures. The tutor had arranged for a technician to join the lectures to help the students. This person could orientate the students step-by-step to solve their technical problems. The students knew in advance about the technician and could ask him for help using private communication. (Transcript 4.5)

… BK (private): Escuse me, but i do not know how to see it.

<Technician (to BK)>: hi boulos...

BK (private): Hi ...

<Technician (to BK)>: can you see the agenda in the left-hand bar?

BK (private): Yes i can see it.

<Technician (to BK)>: ok, if you double click on the second item in the agenda

<Technician (to BK)>: you should get the powerpoint

BK (private): is it the shared pointer?

<Technician (to BKl)>: no, you need to click on 'problem solving'

<Technician (to BK)>: it is at the top of the list

TN (private): Warning! This student is experiencing severe network congestion.

BK (private): I can't see it in the Agenda list.

<Technician (to BKl)>: ok, can you try closing LearnLinc, and re-joining the class?

BK (private): Ok.

<Technician (to BK)>: see you soon

BK (private): I think it is working now ... Thanks a lot.

<Technician (to BK)>: welcome back - can you see it in the agenda?

BK (private): yes ... and i can follow now with the presentaion.
<Technician (to BK)>: great! …

… … …

… AA (private): JO
AA (private): I MA STILL NOT READING ANYTHING'
<Technician (to AA)>: I think it is bandwidth if you are not getting the spreadsheet
<Technician (to AA)>: Do you still have appshare open?
AA (private): NOW I HAVE LOST BOTH THE SPREADSHEET AND THE WORD SCREEN
AA (private): IT IS NOT OPENING NOW
<Technician (to AA)>: One moment...
AA (private): I CLOSED IT AND TRIES OPENNING AGAIN AND OPPS
<Technician (to AA)>: did that help albert?
AA (private): NO PE
<Technician (to AA)>: ok...
AA (private): GOT IT
<Technician (to AA)>: Great :)
AA (private): DANKE SCHÖN …

Another way of using the text chat facility was for day-to-day communication among the participants to express their feeling towards the group situation. (Transcript 4.6)

Many students used the text chat facility to greet each other when joining as well as at the end of the lectures.

… Technician: Goodnight
HB: Thank you!
EO: good night all!
BK: Thanks Good night …

… … …

… IU: You can call me Dixon …

They also have 'social talk' to someone else in their own language. The text chat became a way of having a private conversation (Transcript 4.7).

… AA: laban

IU: Laban are u there …

There is evidence of use of humour, punctuation for conveying emotional tone (emoticons) and native language (transcript 4.8).

… AA: i am good with safes but not with cars

Technician: i've got the car

BK: and I will call the police :-)

AA: dive into the middle of the Nile –bulos …

… … …

Technician: Rosa - Small technical glitch!!

Technician: :)))) lol

… … …

… GB: Yes! :)

EO: no page :'(…

… … …

… AA (private): DANKE SCHÖN …

One fact that showed the potential of this kind of environment was that a student wrote down that he really enjoyed the lecture (Transcript 4.9).

… LH: Today's session is great …

4 DISCUSSION

Students were introduced to this pilot study by the tutor, who told them that the module was taking part in a research study to evaluate the communication tools of that specific VLE and asked them to complete the questionnaires and diaries.

The pilot study received only five questionnaires back from the first questionnaire. No completed questionnaires were received from the end of the module questionnaire and no diaries either.

There are a number of possible reasons for such a low response rate to the questionnaires, such as: some people do not like answering questionnaires or are not used to doing so. However, there are three main possibilities. First, the participants did not receive any compensation to participate. Second, it was an elective module, so their commitment to the module was already low. Finally, the last lecture, where the tutor should have set out the assessment, never took place.

The answers from the questionnaire showed that the participants were comfortable with the online technology environment and the communications tools, especially e-mail. Working in groups and having online discussion appeared to be not so motivating for the participants. These findings showed that working collaboratively online was the biggest challenge for that particular group. In fact, working collaboratively online seems to be the biggest challenge for most virtual learning environments.

It is possible to say that the observational study confirmed that the students had good motivation to engage in an online course and were confident with the technology. They would make use of the communication tools, such as floor

holder, during the lectures to ask questions to the tutor and text chat to communicate with the others. The LearnLinc™ provided an online environment where the lectures can be very similar to the ones delivered face-to-face.

Another similar pattern with traditional face-to-face lectures is that the students just show up for the lectures or listened to the recordings during the period of time that the module last.

The original intention of this research was to study in which ways the students used the communications tools to collaborate with each other using an online environment. However, to collecting data from participants of an online course proved to be very difficult, with a very disappointing level of responses from the questionnaires.

It appears to be quite difficult to find online courses where the researcher could take part and collect data and the research did not want to simulate an artificial environment to measure collaboration as this would generate even more unrealistic results.

Bearing this situation in mind it emerged that it might be better to change the strategy and instead of measuring the students' attitudes to the use of the communication tool in collaborating with each other and measure their attitude to the online environment itself. Therefore, it was agreed that it would be more rewarding to develop a prototype of an online environment that made it possible to collect a proper amount of data to conduct a statistical analysis about the participants' feelings when using the interface

Part III

Empirical studies

Chapter 5

Experiment 1: Applying aesthetics

1 INTRODUCTION

The use of virtual learning environments (VLEs) to deliver online learning is a well established practice. However, the concerns with the interface aesthetics of VLEs are at an early stage and there are important issues to be addressed in order to improve teaching and learning as well as the users' perception of pleasure in using the VLE.

Studies reported in the literature give relevant scientific evidence of how important aesthetic attributes are and the role they play in interface design (various authors). They suggest that a new approach to aesthetics within interface design is no longer a matter of beauty or fashion but also of usability and users' satisfaction.

In Japan, Kurosu and Kashimura (1995) presented the results of an empirical study on aesthetics and perceived usability using layouts from automatic teller machines (ATM) as stimulus material and found a strong positive correlation between them (chapter 3). The ATM layouts were developed on demand by a group of 26 people (e.g. GUI designers, industrial engineers, engineers and secretaries) for Kurosu and Kashimura (1995). The results motivated Tractinsky (1997) to replicate the same study in a different culture, Israel. He strongly believed that the previous results were caused by the cultural background (e.g. the Japanese were motivated by the aesthetic aspects and Israelis by the

functionality of the interface). It used the same ATM layouts, which were developed following seven usability attributes in order to achieve beauty.

The present study aims to corroborate these findings on aesthetics and perceived usability applied to VLEs. However, it uses a more direct approach manipulating aesthetic attributes using design principles to develop the interface screen layouts. The study is to test the following hypotheses: (i) that the use of design principles can be an important factor to determine the aesthetics of computer screen layouts and (ii) that aesthetics are related to users' perceived usability of the system (iii) that aesthetics are interweaved with hedonic characteristics (Hassenzahl, 2004).

The development of the stimulus material for this first study was based on empirical work conducted by Chang, Dooley and Tuolinen (2002), who identified 11 distinctive laws that represent the major aspects of Gestalt theory about visual form and which seem to contain the most relevant aspects for computer screen design. In addition, there is the research of Ngo, Teo and Byrne (2003), who proposed 14 aesthetic measures for graphic displays. Their empirical studies have suggested that effective application of these measures may help gain users' attention and build their confidence in using computer systems.

It also considered the technique of dynamic symmetry elaborated by Hambidge (1926) based on the use of golden section and root rectangles, which shows that only dynamic rectangles can form a pattern where only certain rectangles of the same theme co-exist.

The screen layouts were developed based on the use of a grid generated by dynamic symmetry because it enables control of the visual elements during the development process, saves design time and helps to ensure unity and homogeneity throughout the project. For example, the use of a grid to develop

the stimulus material helps give the whole VLE environment a similar look and feel.

The literature shows evidence that aesthetics have influence on users' perception of usability. It also provides many theories about how to measure beauty and achieve aesthetic pleasure. The dynamic symmetry technique was used to set up the grid of the compositional space in which the design principles (unity, proportion, homogeneity, rhythm and balance) were then taken into account to develop the proposed VLE environment used as experimental stimulus.

So, for the purpose of this study, what we call *aesthetics* is the application of design principles in such a way as to measure the interface aesthetics. It is believed that using the design principles can possibly become a pragmatic model to effectively model the users' perception of attractiveness and usability without involving subjective or personal opinion about what aesthetics is.

2 PILOT STUDY

A pilot study was conducted in a single day with five participants: two lecturers and three members of staff of a Higher Education Institution (UTFPR) in Brazil. They did the experiment one at a time, in a controlled environment, to check that the program would work correctly and the desired data were being recorded properly. We also measured their attitudes and understanding towards the stimulus material. After they finished the experiment they were asked to comment on their impression about the stimulus material and its operation.

The observation of the participant actions showed that the last part of the experiment was not clear enough. The participant had an intermediary screen with instructions explaining how to proceed on that specific part in order to evaluate the hedonic characteristics of the three screens where the design

principles were applied using a paper questionnaire. Three participants finished the experiment on the computer and then realized that they had a paper questionnaire to complete. They completed the questionnaire without looking at the screen they were evaluating; however, there were no comments or complaints at all. This showed clear evidence that something needed to be done to improve users' comprehension and also provide an extra way of visualising the screens to make the evaluation. This deficiency was overcome by placing in the program an informative sentence before the button 'Continue' and also by having a half page black and white image of the relevant screen printed with the questionnaire.

The participants' opinions were mainly concerned with their performance and choosing the correct answer. Two participants were intrigued by the similarity of the screen sets, asking if it was correct. The similarity of the screens is due the fact they use the same elements, colours, etc, just varying in layout.

The pilot study showed the technical part of the program to be working well and the desired data were being recorded in a satisfactory way. It proved to be a good tool to improve and tune the main experiment. It also gave a better picture of what it would be like to run the main experiment, bringing more confidence to the researcher.

3 INTRODUCTION TO THE EXPERIMENT

3.1 Part 1

The first part (Figure 5.1) presented five schematic screens consisting of rectangular blocks that encompass the five design principles (unity, proportion, homogeneity, balance and rhythm) derived from Ngo *et al.* (2003). Each principle was shown in a single page using two figures, one that followed the principle

(screen A) and the other that violated it *(screen B)*. Participants were instructed to choose the screen they would prefer *(A or B)* based on their own impression of the best layout.

These five principles were chosen based on reports from the areas of psychology, design and architecture. The literature shows evidence that these five principles are easy to assimilate and very important in any kind of design structure having a big impact of the participants' perception of aesthetics. Also they are widely used by designers who consider them essential in any kind of design project.

- Unity is the extent to which the screen elements seem to belong together so completely that they are seen as one thing.
- Proportion is defined as the comparative relationship between the dimensions of the screen components and proportional shapes.
- Homogeneity is defined as how consistently the content and the objects are distributed among the four quadrants of the screen.
- Balance can be defined as the distribution of optical weight in a picture.
- Rhythm is defined as the extent to which the objects are systematically ordered.

Chapter 3 presents a more complete definition of these design principles.
Figure 5.1 shows the stimuli that were used in the first part of the experiment. The screens used the colours navy blue for the background and orange for the figure. The five design principles were tested to verify their validity to measure aesthetics. Each one was showed on a computer screen where *screen A* followed the principle and *screen B* violated it.

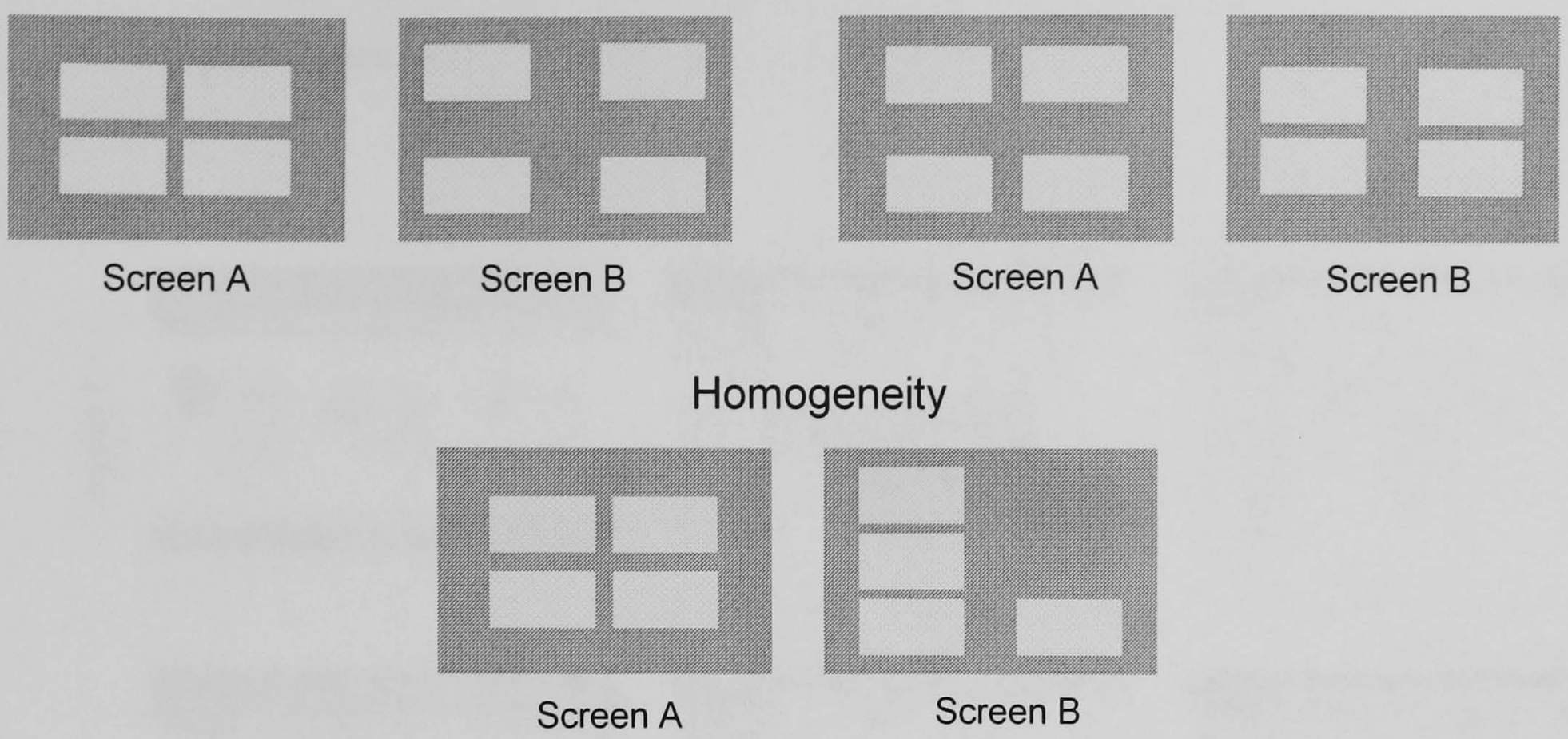


Figure 5.1: The stimuli used in Part 1. ** In each one Screen A follows the principle and Screen B violates it.

3.2 Part 2

For the main part of the experiment, each set of page screens reproduced real web pages that used the same colours and typography on four different layouts to limit the conditions of the experiment (Figure 5.2).

- Layout 1 *(all)*: follows the design principles (unity, proportion, homogeneity, balance and rhythm):
- Layout 2 *(none)*: violates all of them;
- Layout 3 *(p1)*: complies with the first three design principles and violates the other two;

- Layout 4 *(p2)*: violates the first three and obeys the last two design principles.

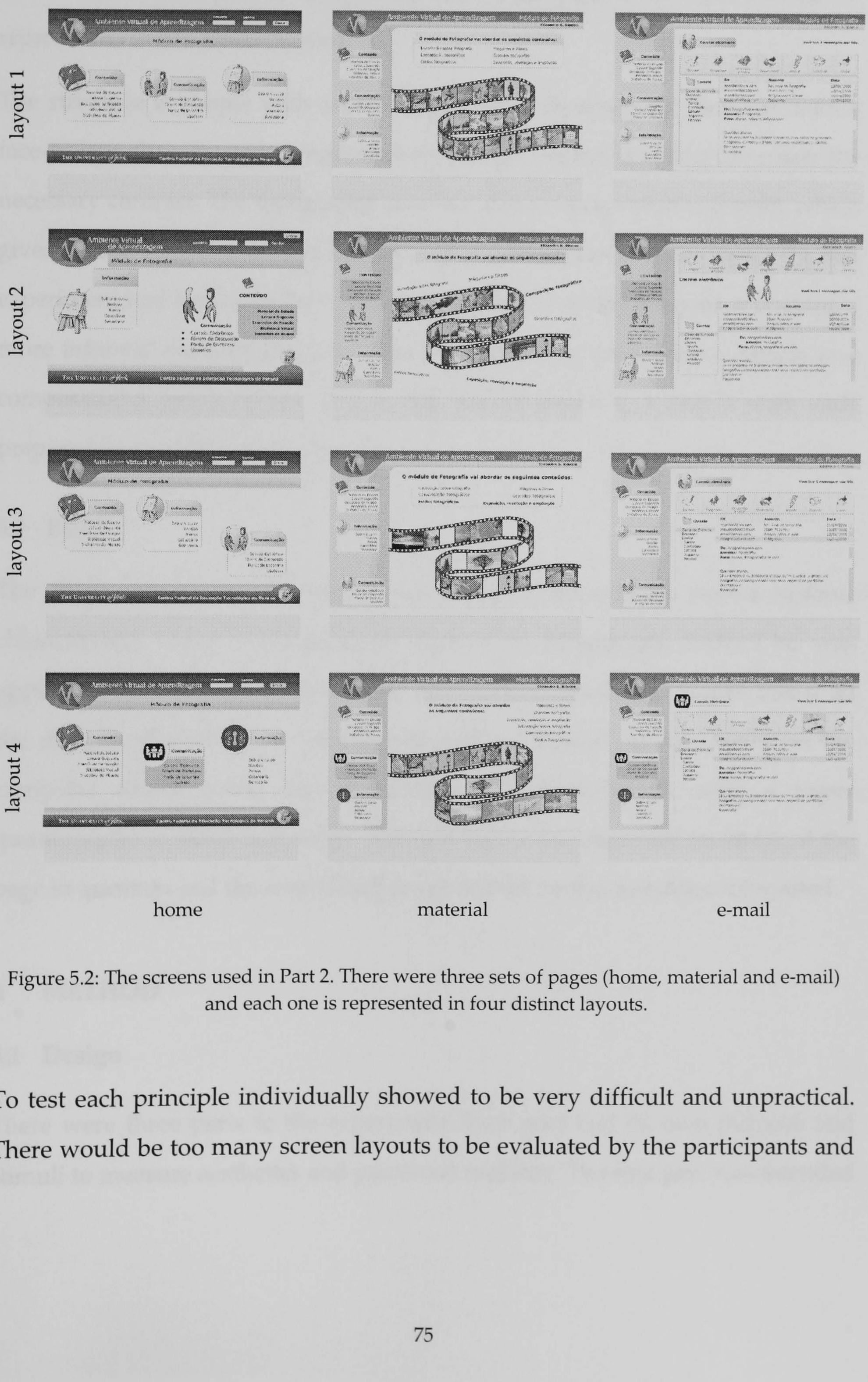


Figure 5.2: The screens used in Part 2. There were three sets of pages (home, material and e-mail) and each one is represented in four distinct layouts.

To test each principle individually showed to be very difficult and unpractical. There would be too many screen layouts to be evaluated by the participants and

also it would be very difficult to elaborate a distinctive screen layout for each one of them. The reason to combine unity, proportion and homogeneity *(p1)* is because these principles are closely related and can be illustrated in a single screen layout. Balance and rhythm *(p2)* also share similar concepts and can be represented in one screen layout.

The structure is simple with artistic design icons representing elements from a face-to-face class. It used complimentary colours (orange and blue) to create the necessary contrast. The typography used for the text was Verdana (black), which gives a good legibility on this kind of media. The graphical style chosen for this experiment had been based on 'cartoon drawings' with the purpose of creating a more informal environment and clean interface using the golden rectangle as a compositional space. When in use, the sets of pages 1, 2 and 3 were each prepared in four different layouts.

3.3 Part 3

The third part of the experiment was designed to evaluate twelve hedonic characteristics using a questionnaire devised by Hassenzahl (2004). T his was applied to three layout screens *(home, material* and *e-mail)* that would follow all the design principles. The participants had a coloured layout shown on the computer screen while they evaluated the screen layout using a paper questionnaire in black and white. The first half of the page had an image of the page in question and the second half presented the twelve questions to be rated.

4 METHOD

4.1 Design

There were three parts to the experiment. Each part had its own purpose and stimuli to measure aesthetics and perceived usability. The first part was intended

to evaluate the importance of the design principles using five pairs of schematic screens. In part 2, we collected data on users' perception of the attractiveness and usability of the interface of three sets of screen page, each one differing according to four layouts. In part 3 we collected participants' opinions about the hedonic characteristics of the interface for a correlational analysis.

4.1.1 Design of part 1

The experimental design was within-subjects with two alternative forced-choice. It intended to measure the participants' preference between the layouts of *screen A* and *screen B*.

4.1.2 Design of part 2

The experimental design for the ratings had three independent variables: *group* is a between-subject factor with seven levels (Arts, CS, Eng, MSc, Lect, Staff, Siem); *layout* is a within-subject factor with four levels (layout 1, 2, 3 and 4); *page* is a within-subject factor with three levels *(home, material* and *e-mail)*. The Latin square method was used to counterbalance the order effect.

4.1.3 Design of part 3

The experimental design was within subject and used a 5-point Likert scale to present twelve bipolar verbal anchors out of the 21 hedonic and pragmatic attributes devised by Hassenzahl (2004) and translated into Portuguese on a paper questionnaire (Appendix 2).

4.2 Participants

The study involved 279 participants enrolled or working at a Higher Education Institution in Brazil (UTFPR) and Siemens-Brazil, divided into seven groups as follow:

- undergraduate students from Design course (42; 22 males and 20 females);
- undergraduate students from Computer Science course (41; 31 males and 10 females);
- undergraduate students from Engineering courses (68; 59 males and 9 females);
- graduate students from an MSc course on Technology and Innovation (45; 18 males and 27 females);
- lecturers in various subjects (33; 21 males and 12 females);
- members of non academic staff (38; 13 males and 15 females);
- employees of Siemens-Brazil that were involved with their own Virtual Learning Environment (12; 5 males and 7 females).

The mean age was 28. Ages ranged from 18 to 62 years old. Overall there were 169 males and 110 females.

4.3 Material and apparatus

In order to replicate the most usual conditions of use of a VLE and, at the same time, allowing the researcher to take observational notes, we used a controlled environment room with fluorescent lights separated from the main room by a shoulder-height glass wall. The personal computers (PCs) used had 256 Mb, 17'' cathode-ray tube (CRT) monitors that were calibrated to display the same colour values, contrast and brightness. We used three PCs, allowing three participants to take the experiment at the same time. The PCs were positioned so that the participants could only see their own screen.

4.3.1 Material and apparatus for part 1

The first part (see Figure 5.1 for stimuli used) presented five screens that encompass the five design principles (unity, proportion, homogeneity, balance and rhythm) derived from Ngo et al. (2003). Each principle was shown in a single page using two figures, one that followed the principle (*screen A*) and the other that violated it *(screen B)*. Participants were instructed to choose the screen they would prefer *(A or B)* based on their own impression of the best layout (full experimental package material in Appendix 2).

4.3.2 Material and apparatus for part 2

The second part simulated specific areas of a virtual learning environment (see Figure 5.2 for stimuli used). It used non-interactive software that just allowed the participants to give ratings for each of the layouts. The first set of pages *(home)* was intended to give the participant a general idea about the environment. The *material* pages simulated an introduction to a module on Photography. Finally, the *e-mail* pages enabled the participant to have access to the most commonly-known and used communication tool (full material in Appendix 2).

Each set of pages was composed of four different layouts. Layout 1 would follow all the design principles *(all)* and layout 2 *(none)* violated all of them, layout 3 complied with unity, proportion and homogeneity and violated balance and rhythm *(p1)* and layout 4 *(p2)*, which did the opposite, complied with balance and rhythm and violated unity, proportion and homogeneity.

4.3.3 Material and apparatus for part 3

The third part was composed of a screen layout that applied all design principles from each set *(home, material* and *e-mail)* shown on the computer and a paper questionnaire. It presented one layout at a time followed by eight questions

related to its hedonic attributes and 4 questions related to its pragmatic attributes. The questions used a 5-point Likert scale and were repeated for each one of the three screen layouts.

4.4 Procedure

As part of the ethical procedure from the Psychology department, the Vice-Chancellor provided signed permission to run the experiment with the members of staff, lecturers and students of the educational institution. This was then communicated to the heads of department of the target undergraduate courses, who also agreed to give support by recruiting participants.

The experiment was advertised through the institution's official e-mail and invitations in some classrooms (e.g. designers, computer science and engineering undergraduate courses) with the agreement of the lecturers. A timetable was made available so the participants could choose a time and day to take part in the experiment (e.g. from 8am to 9pm, Monday to Saturday, mainly, for three weeks).

All the participants were required to read a letter informing them of the purpose and the ethical procedures of the study. After that, the researcher gave additional information about the tasks and made sure they understood that the study was just intended to measure their perception about how attractive and easy to use the proposed VLE environment was. So, the aim of the study was to find what users perceive to be aesthetically pleasing in an interface and its relation to perceived ease of use.

The study tried to replicate what is believed to be the most usual condition of use of a VLE environment, using a computer and not having another person's help and immediate advice.

4.4.1 Procedure for part 1

The experiment started by presenting five sets of two screens (total of ten screens) that encompass five design principles. Each principle was evaluated separately on a screen showing two different layouts with the same colour and elements, one that followed and another that violated the design principle being evaluated (Figure 5.1). Participants were instructed to choose the one they would prefer *(screen A* or *screen B)* based on their impression of the best layout. They would click on a button to choose *screen A* or *screen B*, then the next principle was presented.

4.4.2 Procedure for part 2

Before they started the second part of the experiment, they saw an intermediary screen instructing them simply to observe the four different screens shown. Then, the first set of pages for *home* screens were shown so that the participants had a chance to see each of the four screens for four seconds, like a little *trailer preview*. The reason for doing this was to give the participant an opportunity to see all four screen layouts before evaluating them. After that, the four screens were presented again and the participants had to evaluate them using a 5-point Likert scale, varying from 1 *(unattractive)* to 5 *(attractive)*, from the aesthetic aspect. This process was repeated for the three sets of pages *(home, material* and *e-mail)*. The program then presented the same twelve screens to evaluate the perceived usability, using a 5-point Likert scale, ranging from 1 *(difficult to use)* to 5 *(easy to use)*. They were instructed to evaluate each of the twelve screens again, but focusing on their perception of how easy to use the environment would be, and their satisfaction when navigating this particular VLE. They could spend as much time as they wanted to evaluate each screen and only when they clicked on

the button (①, ②, ③, ④ or ⑤) would the screen change to the next one, registering the data in a separate file.

The program ensured participants gave grades to all the screens in order to complete the experiment. It was not possible to return to the previous screen as this would cause problems in recording and interpreting the data acquired.

4.4.3 Procedure for part 3

In the third part the computer was used to present the screen layout while the participants used a paper questionnaire to evaluate it. The three screens would follow all the design principles, one from each set of pages *(home, content* and *e-mail)*. The paper questionnaire also presented, on the first half of the page, the same screen layout printed in black and white (Appendix 2).

5 RESULTS

5.1 Part 1: Two alternative forced-choice

The importance of design principles was tested through the participants' preference for screen layouts with good or bad application of the design principles. The probability of choosing the layout that follows that specific design principle is illustrated in Figure 5.3.

The binomial tests show that those probabilities all differ significantly from the chance value of .5 ($p < .05$, two tailed). The participants prefer screens that would follow the layout principles over screens that violated it. Figure 3 reveals that the principle of rhythm and homogeneity affected the participants' preference more, followed by proportion and unity. The principle of balance was also significant even though it shows an opposite pattern from the others.

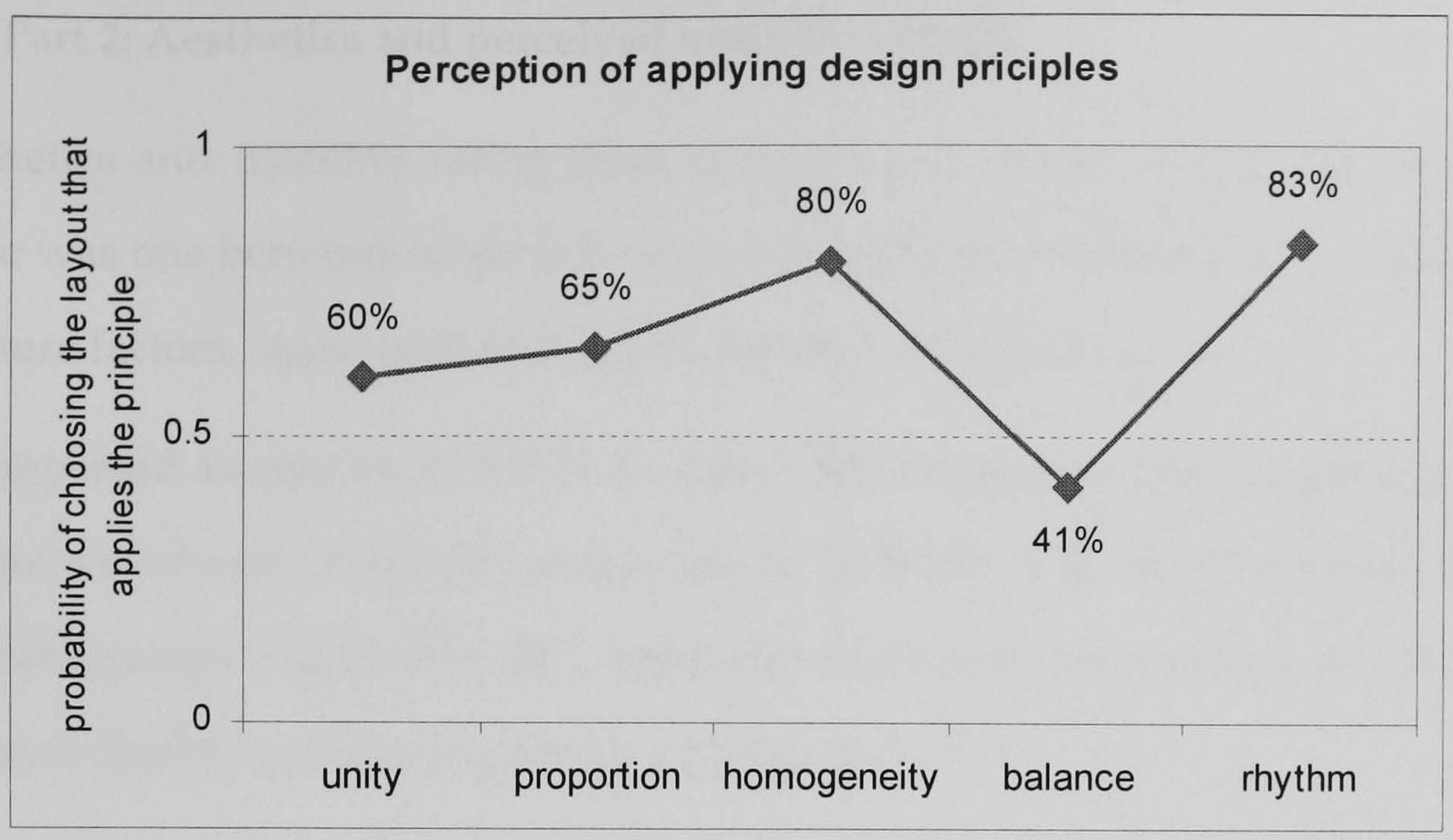


Figure 5.3: Proportion choosing the screen layout that follows the principle.

Figure 5.4 shows the upper and lower limits of the 95% confidence interval for each design principle (assuming a Poisson distribution).

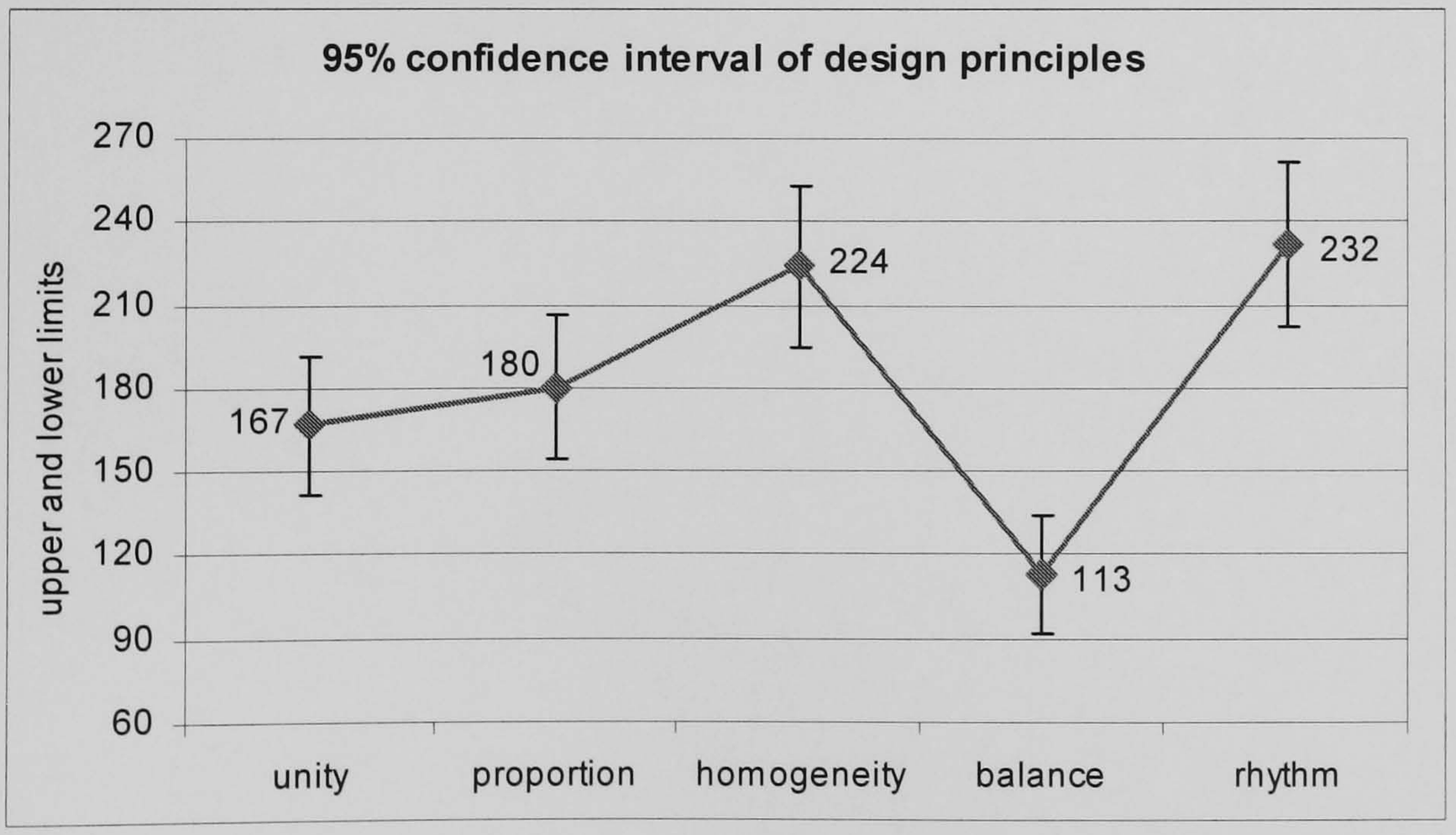
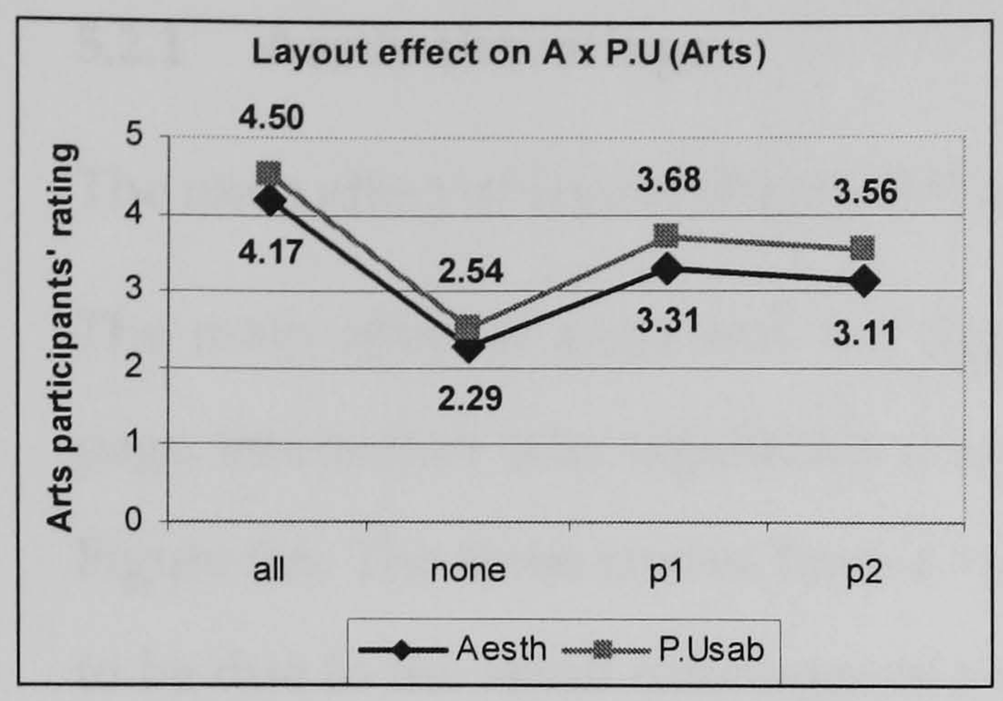


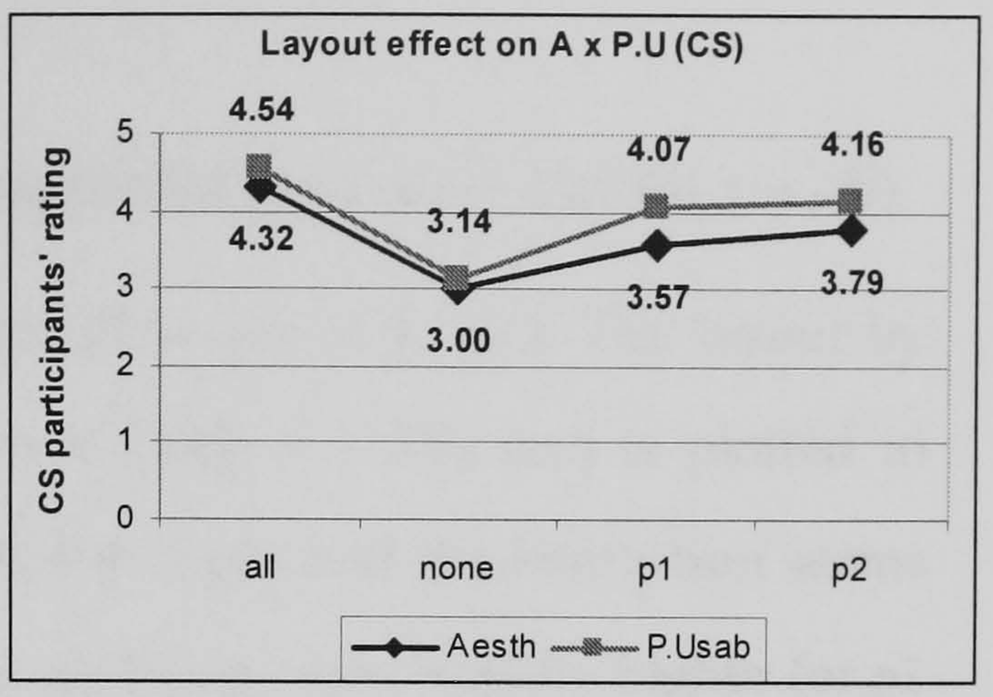
Figure 5.4: 95% confidence interval for each design principle with its upper and lower limit.

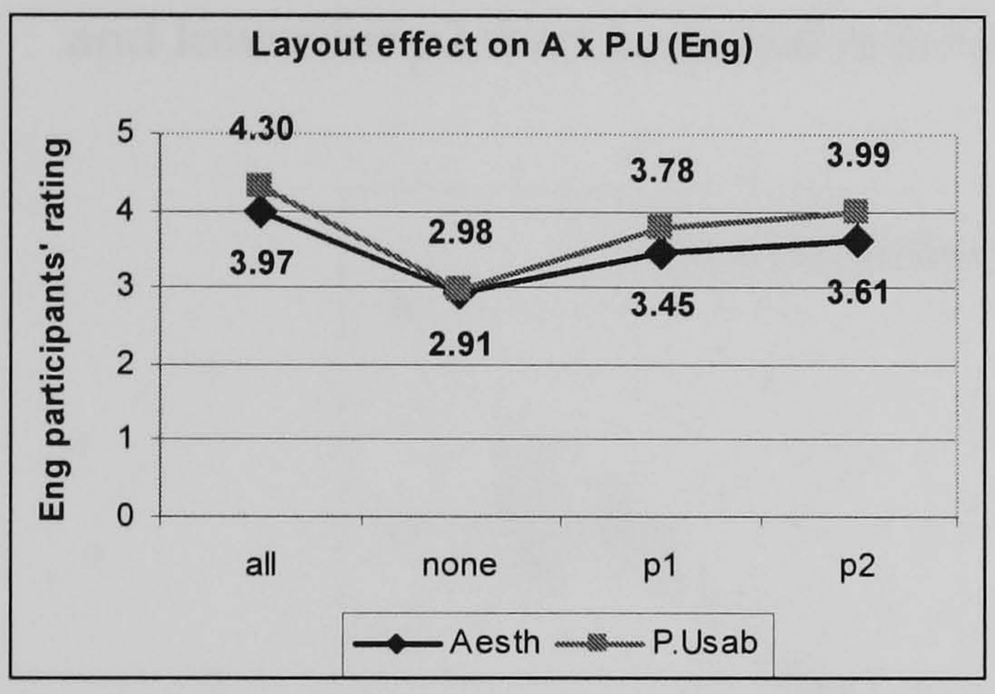
5.2 Part 2: Aesthetics and perceived usability ratings

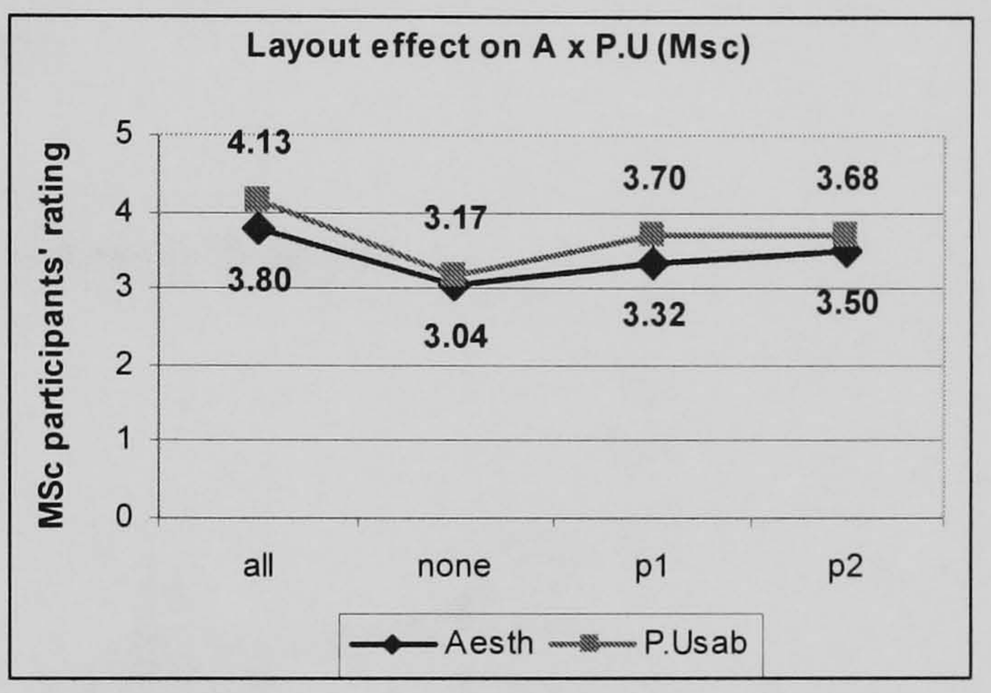
Aesthetics and usability rating were analysed in a 3-way analysis of variance. There was one between-subjects factor *group* with seven levels and two repeated measure factors, *layout* with four levels and *page* with three levels.

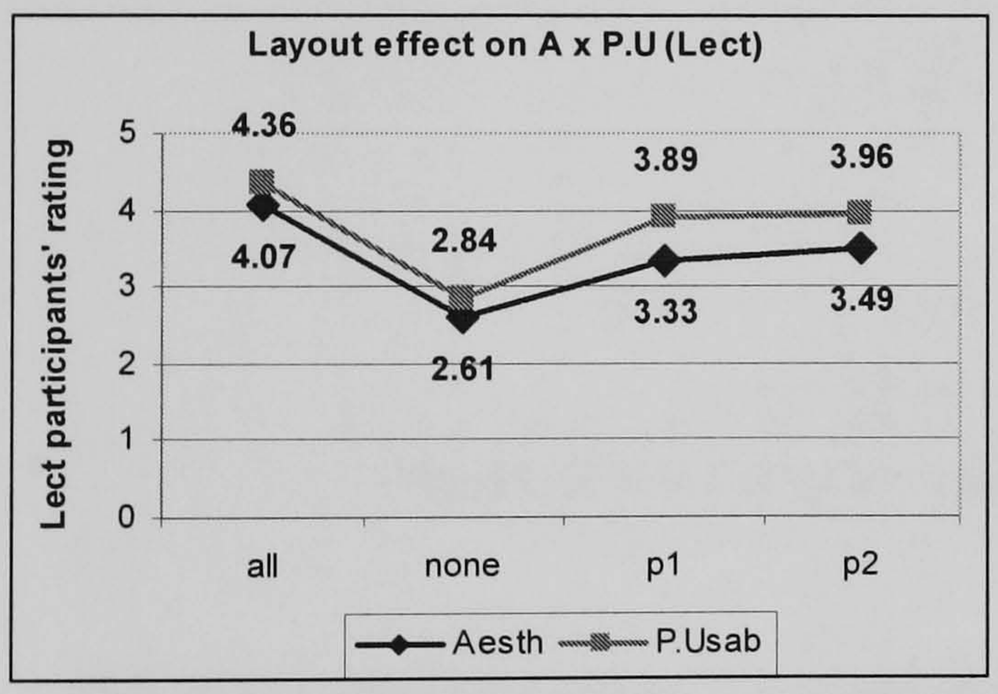
The repeated measures ANOVA reveals a similar pattern for the participants' preference between aesthetics and perceived usability. The results from the seven different groups (Figure 5.5) are comparable and equivalent to the analysis of the 279 participants together (Figure 5.8 and Figure 5.11).

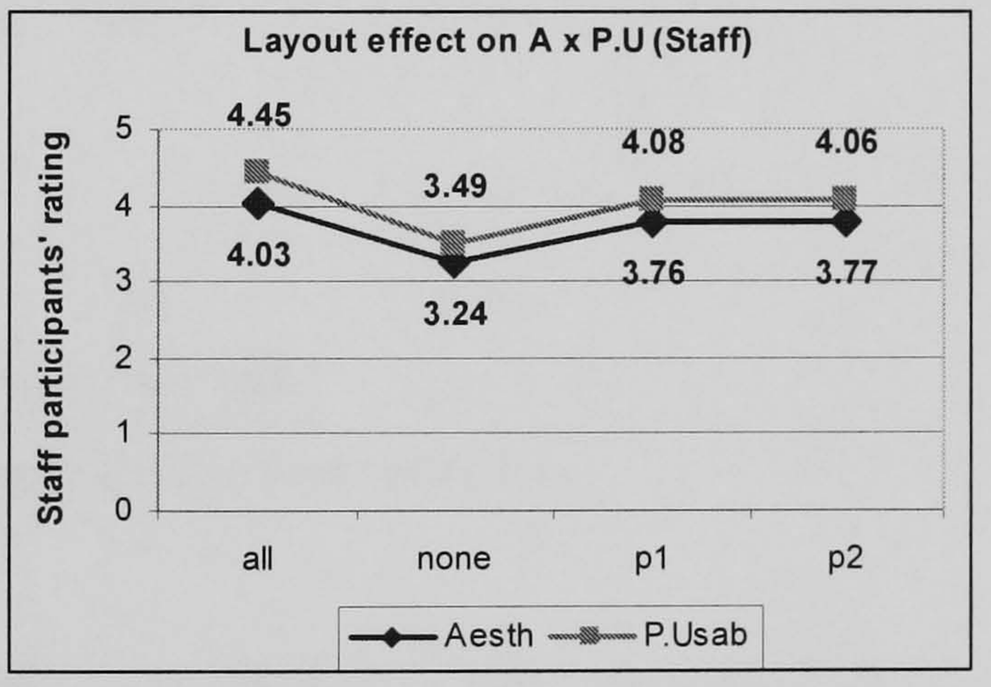












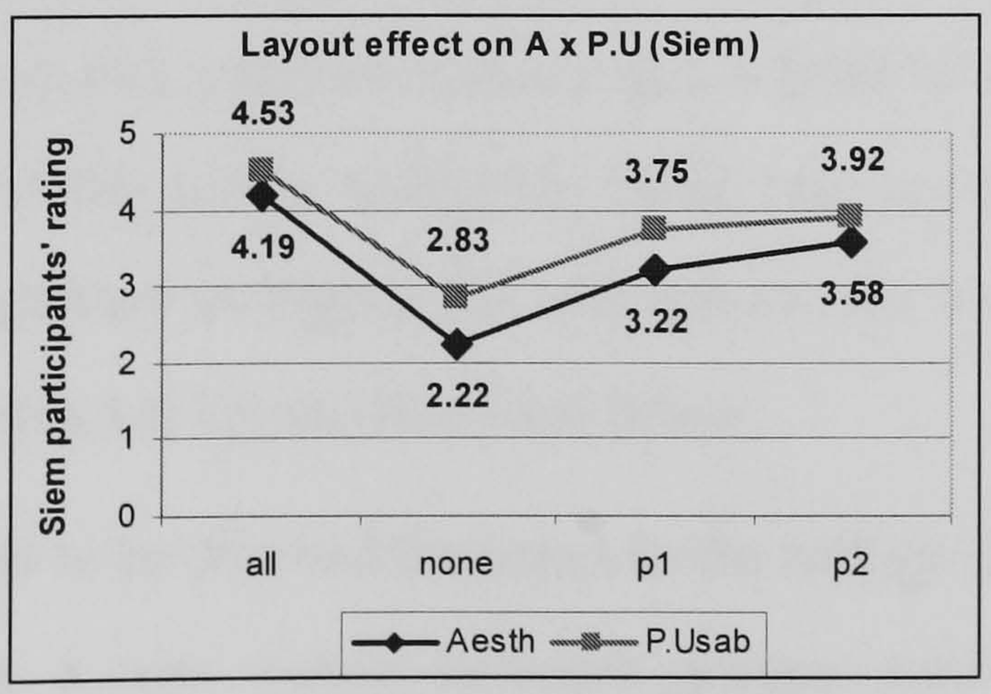


Figure 5.5: Aesthetics and perceived usability evaluation from seven groups reveals the same pattern.

5.2.1 Aesthetics ratings

The main effect of layout (Figure 5.8) was significant ($F_{(2.72, 740.35)} = 112.536$, $p < .05$).

The main effect of page was not significant ($F_{(1.98, 537.39)} < 1$, *n.s.*). The layout by page interaction was significant ($F_{(5.27, 1432.63)} = 7.843$, $p < .05$), and is plotted in Figure 5.6. The three curves have a very similar shape and the interaction seems to be due to the small difference of *e-mail* page being rated slightly higher for *p1* and lower for *p2* than *home* and *material* page.

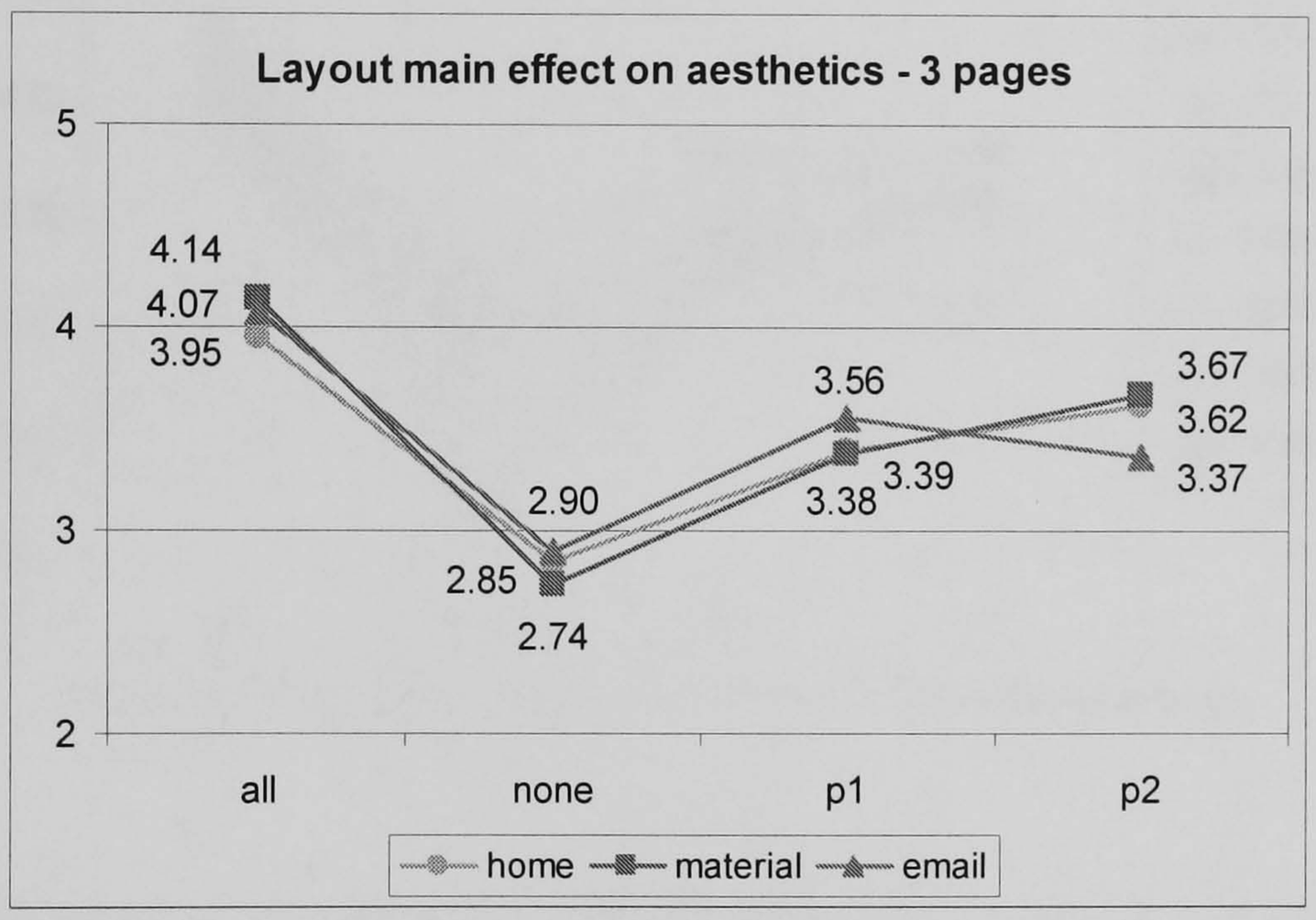


Figure 5.6: Main effect of layout on aesthetics for each set of pages.

The main effect of group was significant ($F_{(6, 272)} = 4.509$, $p < .05$). The layout by group interaction was also significant ($F_{(16.33, 740.35)} = 2.643$, $p < .05$). This indicates that the perception of the layout aesthetics could vary among different groups. This interaction is plotted in Figure 5.7. All curves are very similar in shape following the main effect of layout described below.

The interaction seems to be due to differences in the ratings of the *none* layout. To explore this further a new 1-way between groups analysis of variance as computed using only the ratings of the *none* layout averaged over page. The

main effect of group was significant ($F_{(6, 272)} = 5.635$, $p < .05$). Tukey's *HSD* shows two homogeneous subset where the groups from Art, Siemens and Lectures are significantly different from the groups of Engineers, Computer Science, MSc and Staff.

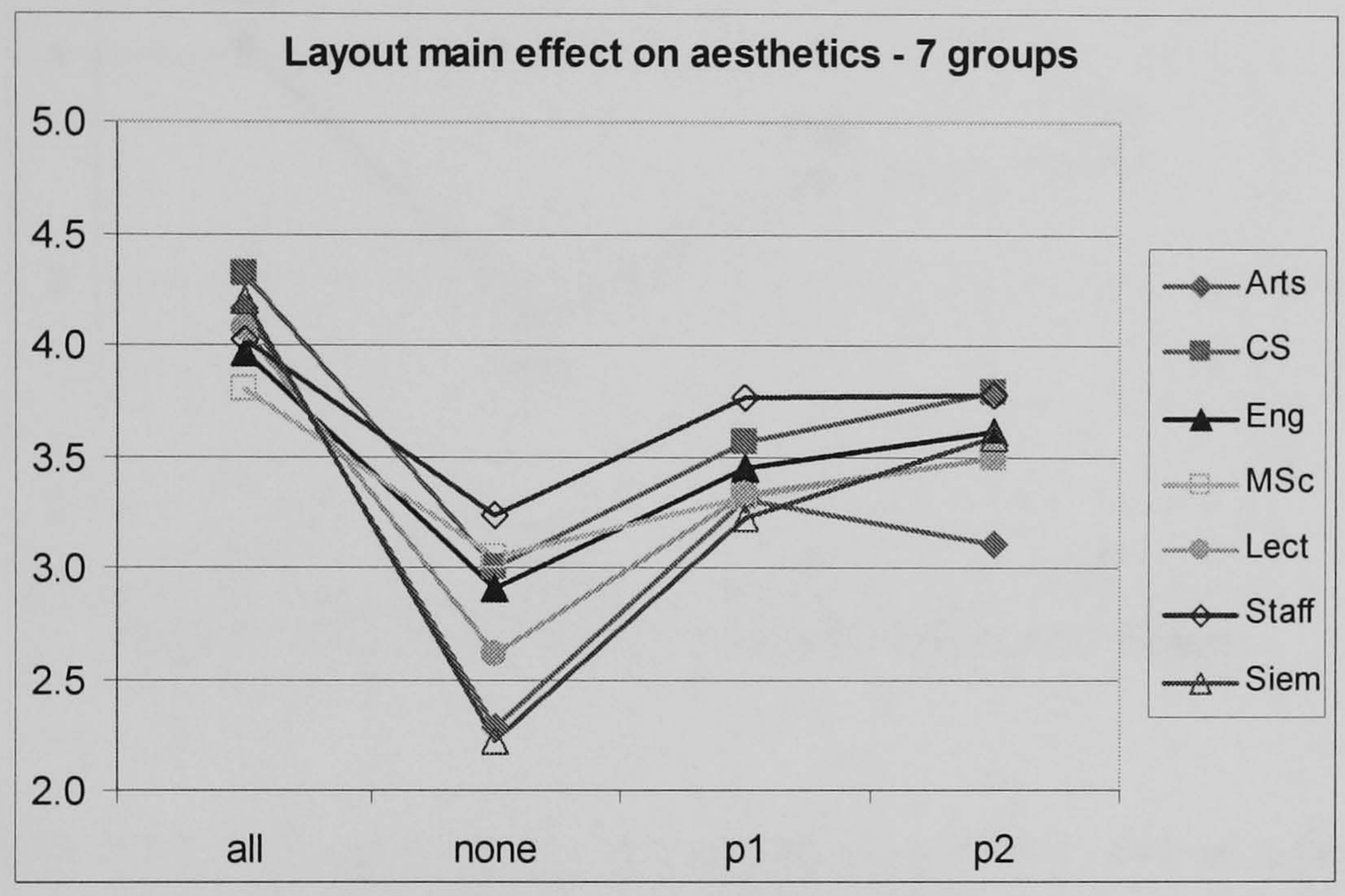


Figure 5.7: Main effect of layout on aesthetics for different groups.

The page by group interaction was not significant ($F_{(11.85, 537.39)} < 1$, *n.s.*), indicating that the type of stimuli does not depend on the group that the participant belongs to. It seems that those with a higher exposure to the design principles (Arts) or to this type of media (Siemems and Lecturers) are more likely to be affected by the *low aesthetics* condition than the others.

The 3-way interaction between layout, page and group was not significant ($F_{(31.60, 1432.63)} = 1.309$, *n.s.*).

Figure 5.8 plots this main effect of layout pattern obtained on the analyses of aesthetics considering the overall number of participants. The layout that follows

all the principles, *all,* gets higher ratings than the other three layouts (*none*, *p1* and *p2*) with the layout that violates all the principles, *none,* getting the lowest ratings.

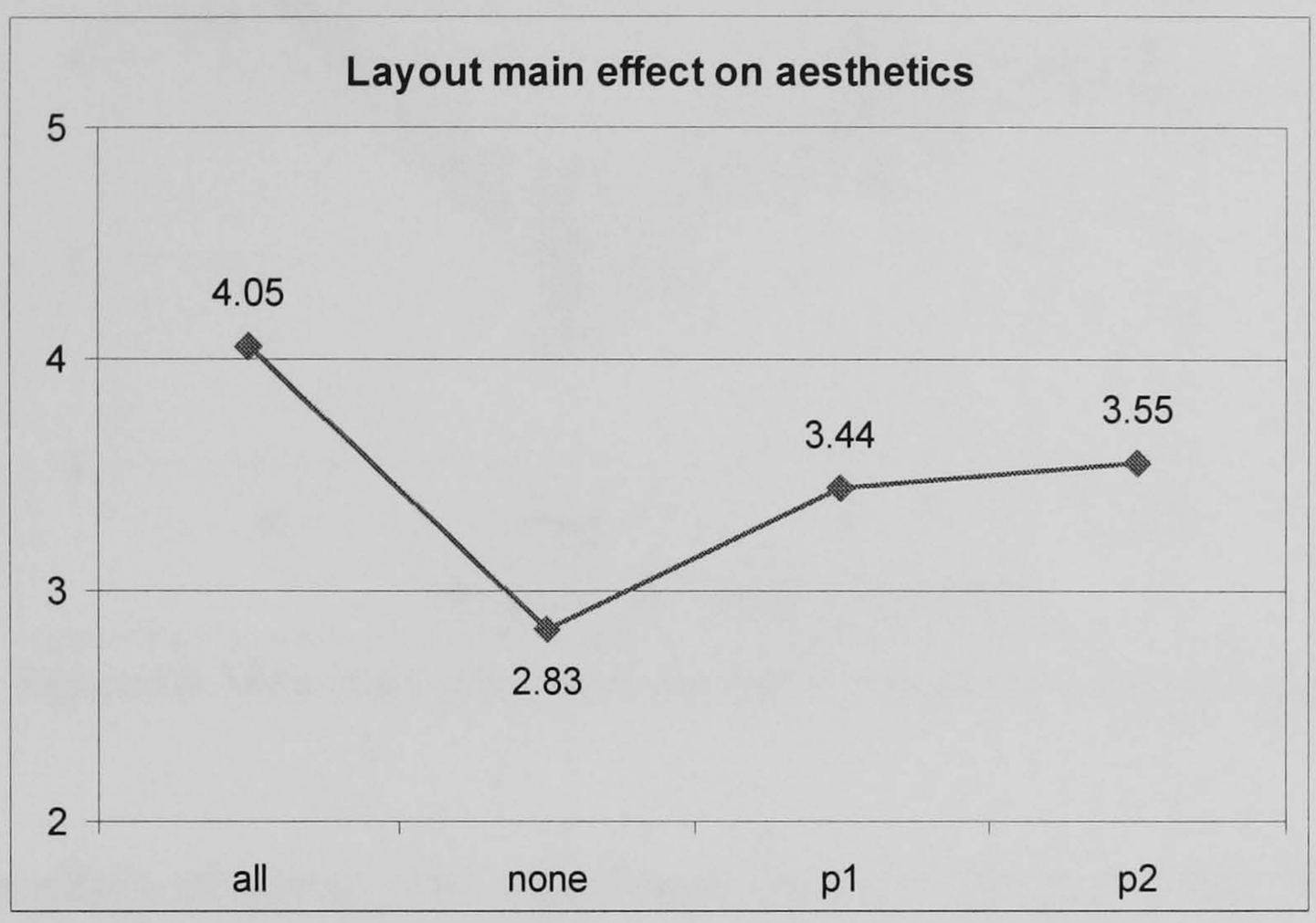


Figure 5.8: Main effect of layout; average from three sets of pages.

Tukey' HSD test for this main effect is computed as $HSD = .166$ on a two-tail test using $q = 3.68$. This shows that the participants perceive the layout that follows *all* the design principles as being more aesthetically pleasing than the others.

5.2.2 Perceived usability ratings

The main effect of layout (Figure 5.11) was significant ($F_{(2.40,\ 655.32)} = 151.913$, $p < .05$).

The main effect of page was also significant ($F_{(1.98,\ 537.39)} = 12.073$, $p < .05$).

The layout by page interaction was significant ($F_{(5.31,\ 1445.11)} = 7.915$, $p < .05$) and is plotted in Figure 5.9. Again, the three curves have a very similar shape and the interaction seems to be due to the small difference of *e-mail* page being rated slightly higher for *p1* and lower for *p2* than *home* and similar rating for *material* page.

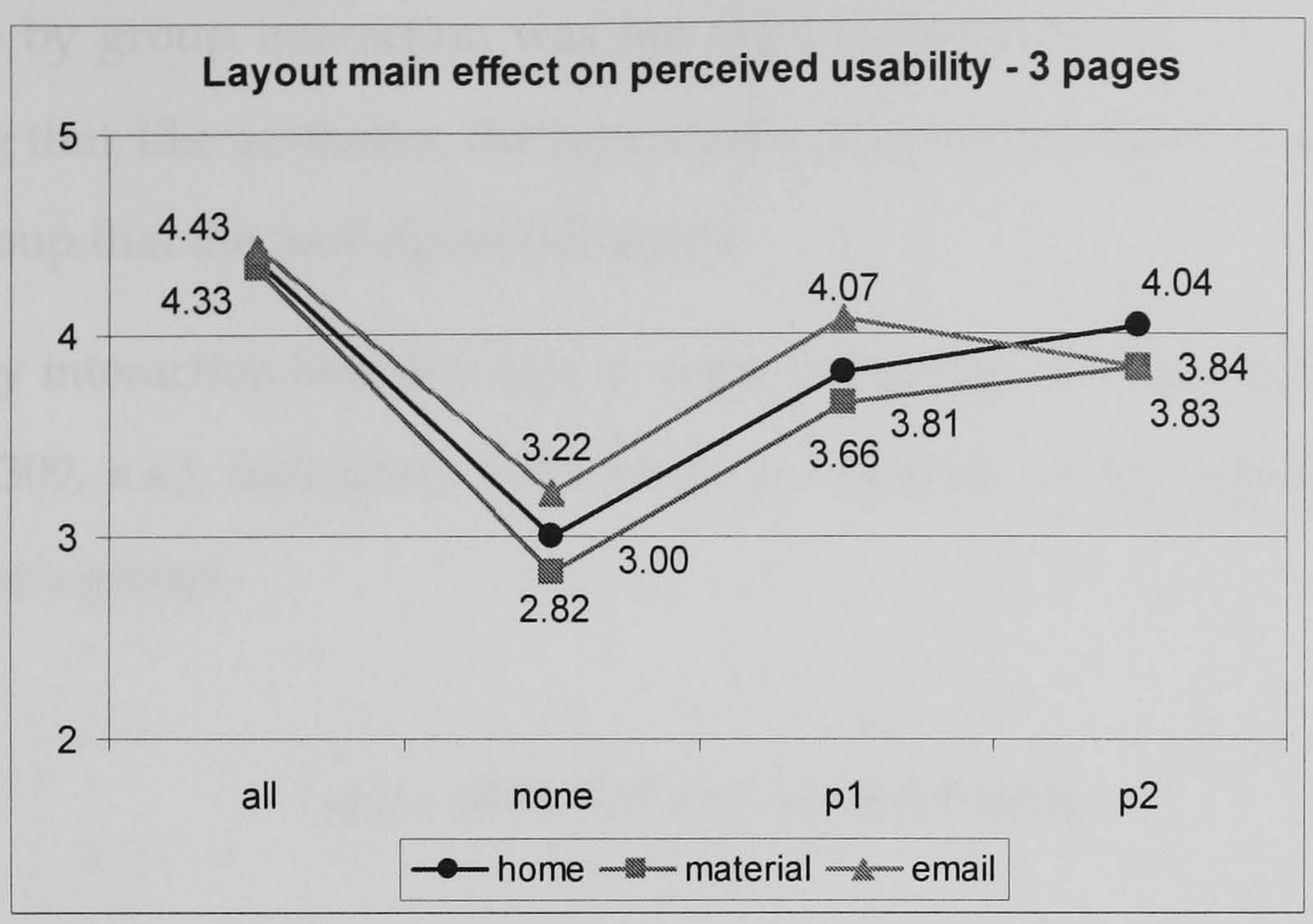


Figure 5.9: Main effect of layout on perceived usability for each set of pages.

The main effect of group was significant ($F_{(6, 272)} = 2.812$, $p < .05$). The layout by group interaction was significant ($F_{(14.45, 655.31)} = 2.280$, $p < .05$), indicating that the perception of the layout aesthetics could vary among different groups. This interaction is plotted in Figure 5.10. All curves are very similar in shape following the main effect of layout described above. The interaction would seem to be due to groups that rated *none* much lower than *all*.

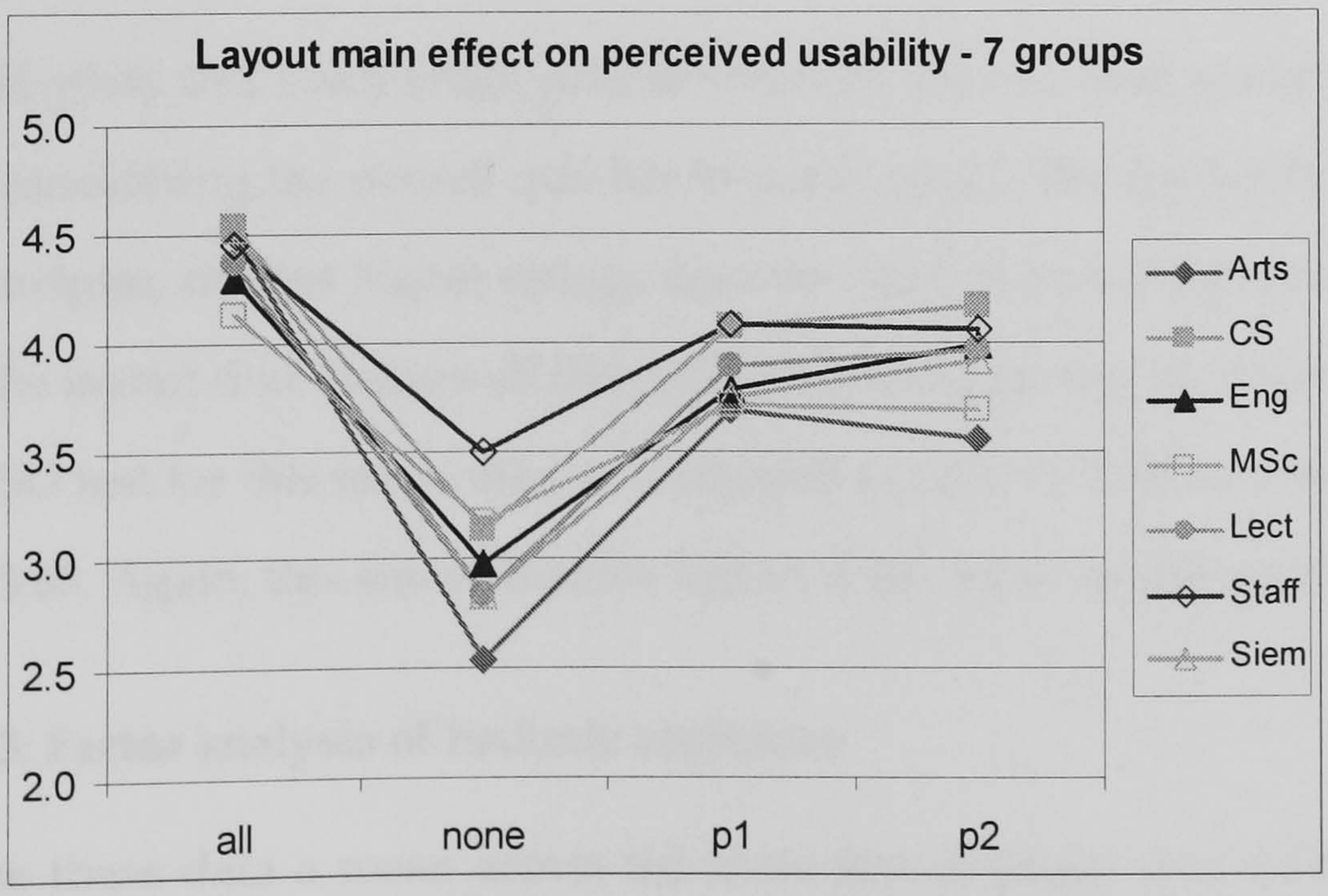


Figure 5.10: Main effect of layout on perceived usability for different groups.

The page by group interaction was not significant ($F_{(11.91,\ 539.83)} = 1.731$, $p > .05$), indicating that, like aesthetics, the type of stimuli (*group of pages*) does not depend on the group that the participant belongs to.

The 3-way interaction between layout, page and group was not significant ($F_{(31.60,\ 1432.63)} = 1.309$, *n.s.*), indicating that perceived usability is not dependent on the participant's group.

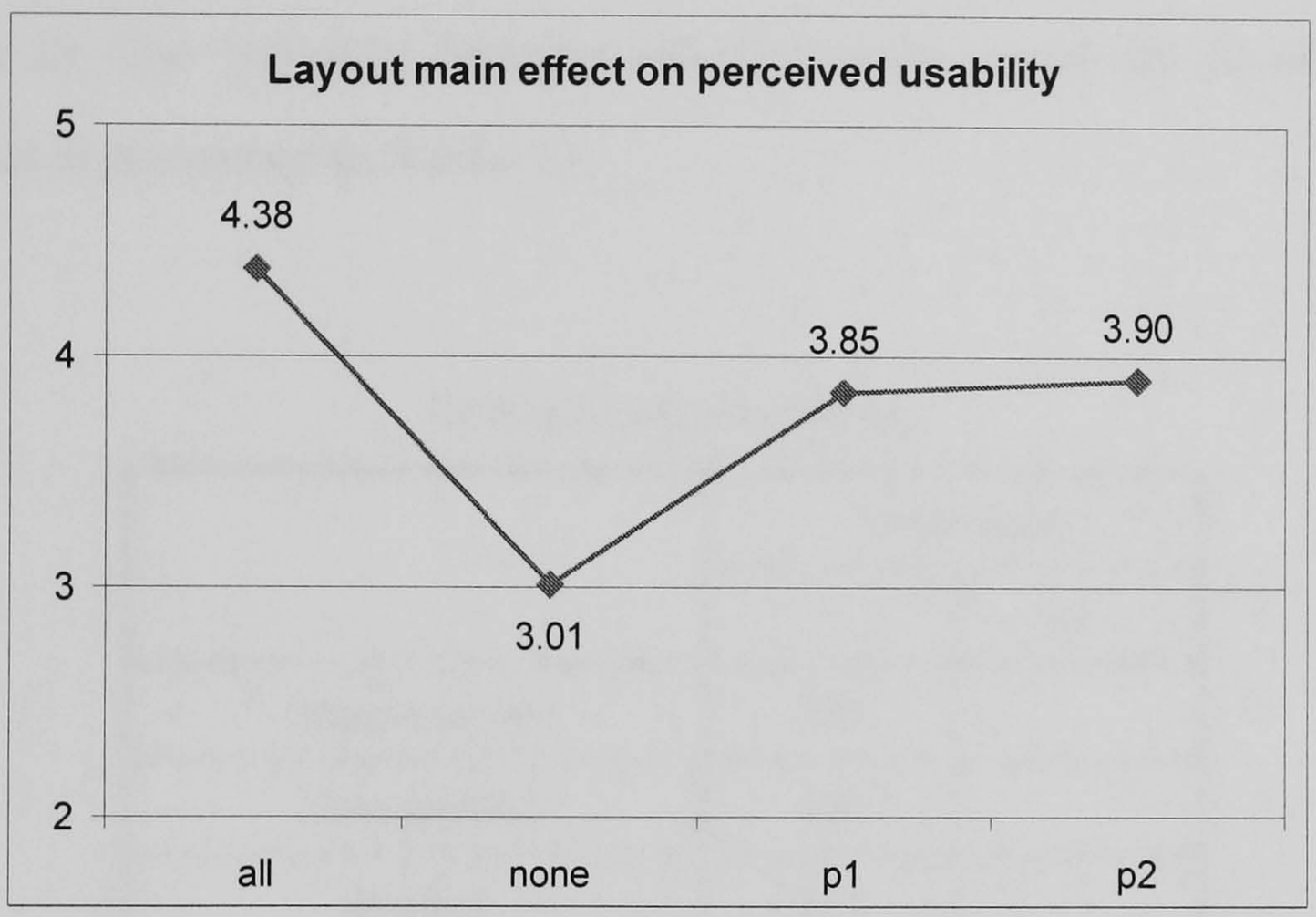


Figure 5.11: Main effect of layout; average from three sets of pages.

Figure 5.11 plots this main effect pattern obtained on the analyses of perceived usability considering the overall number of participants. The layout that follows all the principles, *all,* gets higher ratings than the other three layouts (*none*, *p1* and *p2*) with the layout that violates all the principles, *none,* getting the lowest ratings. Tukey' HSD test for this main effect is computed as *HSD* = .154f on a two-tail test using $q = 3.68$. Again, this shows that the layout is the most important effect.

5.3 Part 3: Factor analysis of hedonic attributes

To analyse these data a mean across the three sets of pages was computed for each participant on each question. The suitability of the data for factor analysis

was assessed by inspecting the correlation matrix, which revealed many coefficients above .3. The Kaiser-Meyerl Oklin value was .889 (the recommended value is above .6) and the Barlett's Test of Sphericity reached statistical significance.

These data were subjected to principal component analysis (PCA). Only two factors had eigenvalues greater than 1, explaining 42.6 per cent and 19.8 per cent of the variance. The screeplot reveals a clear break after the second component (Appendix 2). The Varimax rotation solution (with a cut off .3) of those two components is presented in Table 5.1.

Table 5.1: Structure Matrix.

	Component	
	1	2
Innovative (st)	.882	
Creative (st)	.864	
New (st)	.850	
Modern (id)	.795	
Interesting (st)	.738	.395
Expensive (id)	.707	
Add value (id)	.664	
Clear (pr)		.837
Simple (pr)		.827
Direct (pr)		.813
Predictable (pr)		.733
Classic (id)		.320

All the pragmatic questions were loaded together in component 2. The other questions on hedonic qualities, identification and stimulation, were loaded on

component 1. The hedonic quality identification *classic* seemed to be unclear for the participants and was loaded, quite low (.395) on component 2. The hedonic quality stimulation *interesting* is loaded in both components; however, it loads high (.738) on component 1 and low (.395) for component 2. There is a possibility of mismatch of meaning for the words used due to the fact it was first translated from German into English and then this research translated them again, this time from English into Portuguese.

The total variance explained shows the rotation sums of squared loadings. Component 1 accounts for 4.554 and component 2 accounts for 2.936 of the total variance.

6 DISCUSSION

The results of part 2 of this experiment are relatively simple to interpret. There is a consistent effect of layout such that the results of the repeated measures ANOVA were statistically significant and constant throughout the different groups.

In line with the results of Kurosu and Kashimura (1995) and Tractinsky (2000) discussed in Chapter 3, the ratings revealed similar shapes for both variables, aesthetics and perceived usability, on the four different layouts and three sets of pages. The higher was the rating for aesthetics the higher it was for perceived usability. In this way, the more beautiful the layout was perceived to be the more it was perceived as easy to use.

Part 1 is also consistent with those findings in that aesthetics can be achieved through design principles. The results of a two alternative forced-choice showed that the principle of balance was consistently perceived as not important. One

possible explanation could be that when the principle is presented in a schematic way rather than applied in a context it loses its relevance.

Part 3 addressed a different question. It was to collect evidence of how the participants felt towards the interface that applied all the design principles. The hedonic attributes identification and stimulation were compared with the pragmatic attributes of the interface layouts. The factor analysis revealed two components where the hedonic attributes loaded more highly than the pragmatic attributes.

There are a number of limitations to this experiment. The screens were static and the participants had to rate all 12 layouts in two different aspects. The aesthetic aspect was actually there, they could see it. However, they could not use the interface in order to evaluate its usability, so it was called perceived usability.

These issues will be addressed in the next experiment, with a prototype of a VLE interface which would allow the participants to effectively interact with the environment before rating its aesthetics and usability.

One particular finding of this study is that the perception of aesthetic depends on users' background like field or years of study. It seems that those with a higher exposure to the design principles (Arts) or to this type of media (Siemems and Lecturers) are more likely to be affected by the *low aesthetics* condition than the others. In contrast, the perception of usability does not depend on users' background and it is affected by the aesthetics attributes of the interface, giving evidence that independently of the system target users it is important to have a good layout design.

Finally, the findings in this experiment could form the basis of a model to assess the importance of aesthetics in the context of VLEs. It will also be used, in a

second stage, to verify the correlation of aesthetics and usability in an interactive interface after the interaction.

Chapter 6

Experiment 2: Manipulating aesthetics and usability I

1 INTRODUCTION

Chapter 5, *Applying Aesthetics,* aimed to replicate the results that Kurosu and Kashimura (1995) found with participants in Japan and Tractinsky (1997 and 2000) found even stronger evidence with participants in Israel. This research used a different type of interface instead of an ATM (Automatic Teller Machine) and also another culture (Brazil). The interface chosen was a VLE (Virtual Learning Environment) interface. This type of interface has different requirements from an ATM interface with the aesthetic aspects being more salient to the user, who interacts with a VLE interface due to the fact that it can be used in a personal environment, for longer periods of time than an ATM interface and also over a specific period of time (e.g. duration of the course, weeks or months).

The study used a non interactive VLE interface and found a positive relationship between interface aesthetics and perceived usability. It also tested the importance of five design principles (unity, proportion, homogeneity, balance and rhythm) as a simple way to achieve aesthetics of computer interface.

The results were shown to be statistically significant for all five design principles. This gives evidence that users prefer screens that apply the design principles. It

also intended to find if aesthetics (achieved through applying the design principles) were related to the users' perceived usability of the environment.

The stimuli material used comprised three different sets of pages, *home*, *material* and *e-mail*, each one with four different layouts. Therefore, a total of 12 screens was evaluated for their aesthetic aspects and afterwards, for their perceived usability. The results showed that aesthetics manipulation affected the usability ratings in all three sets of pages and also in all four different screen layouts. Finding such a big effect of aesthetics over usability was unexpected but it could be explained by the fact that the experiment was not interactive and so the participants would give more attention to the aesthetics attributes.

The present study aims to corroborate the findings on aesthetics and perceived usability (Chapter 5) in a VLE context. It uses a more direct approach manipulating aesthetic attributes using design principles to develop the screen layouts for the interactive interface. The study aimed to: (i) confirm the results from the previous experiment *Applying Aesthetics* and (ii) verify if the results would show major differences after the user's interaction with the proposed VLE prototype.

It was necessary to develop a prototype of a VLE interface to work as the stimulus material. This time, the participants had to interact with the interface, performing two tasks, before evaluating the aesthetics and usability of the interface used. This approach is expected to give a more realistic perception of aesthetics and usability attributes than the one used in experiment 1 which used static screen layouts.

2 INTRODUCTION TO THE EXPERIMENT

The two parts on this experiment were directly related with the previous experiment. Each part of the VLE had its own purpose and stimuli to measure aesthetics and usability. Part 1 was intended to evaluate the aesthetic attributes and usability of the interface after the participant had navigated through the VLE prototype to execute two tasks. The VLE interface prototype was developed utilising the screen layouts used in part 2 from experiment 1, where the participants rated the aesthetics and perceived usability of static screens. In part 2, we collected data on the attractiveness and usability of the interface by comparing both *e-mail* layouts rather than one screen at a time as in part 2 in experiment 1.

For both tasks the participant received instructions about his or her role through verbal explanation before starting the experiment and during the interaction they had intermediary screens to orient their actions. In the first task the participants played the role of an enrolled student of that module who receives an e-mail from a colleague asking his opinion on a particular matter and had to navigate through the course *material* pages to be able to reply to their friend's e-mail. For the second task, the participant's role changed and now they are the course tutor who received an e-mail from a group of students asking about the content of week six and also, the amount of time given for one specific topic. The 'tutor' needed to navigate through the course information pages *calendar* in order to reply to the students.

The independent variables, aesthetics and usability, were both manipulated in a between-subject design. The aesthetics manipulation had two levels, one that had all the design principles applied *(high aesthetics)* and the other that violated all of them *(low aesthetics)*. The usability attributes had two levels, one that had one

error message (when entering user and password) and 4s delay between screens *(low usability)* on another without any error message or delays *(high usability)*. The 4s delay occurred between screens, even for the instruction screens; however, during the navigation into the same set of pages' content, such as *material* and *calendar*, there was no delay. Table 6.1 presents the four different groups generated by aesthetics and usability:

Table 6.1: Experimental conditions.

		Aesthetics	
		High	Low
Usability	Low	Group 1 (1A)	Group 3 (2A)
	High	Group 2 (1B)	Group 4 (2B)

3 METHOD

3.1 Design of the experiment

3.1.1 Design of part 1 – Ratings of aesthetics and usability after using the VLE

The experimental design for the ratings was 2x2 between-subject ANOVA with two independent variables: aesthetics manipulation with two levels (*high aesthetics* and *low aesthetics*) and usability manipulation with 2 levels *(high usability* and *low usability)*. It used a 5-point Likert scale for the ratings of aesthetics and usability manipulation.

3.1.2 Design of part 2 – Two alternative forced-choice

This was a simple choice between two screens performed twice, one for preference on the basis of aesthetics and another for usability. It was also a between-subject design with two independent variables: aesthetics manipulation with 2 levels *(high aesthetics* and *low aesthetics)* and usability manipulation with 2 levels *(high usability* and *low usability)*.

3.2 Participants

The study involved 98 participants enrolled or working at a Higher Education Institution in Brazil (UTFPR).

- Group 1 (1A): (25; 13 males and 12 females);
- Group 2 (1B): (22; 11 males and 11 females);
- Group 3 (2A): (23; 11 males and 12 females);
- Group 4 (2B): (28; 14 males and 14 females);

The mean age was 28. Ages ranged from 18 to 57 years old. Overall there were 49 males and 49 females.

3.3 Material and apparatus

This experiment used the same screen layouts used by the previous experiment. However, this time the VLE was an interactive interface and so it tried to replicate the most common conditions of use of a VLE. The room was modified to resemble a study room (e.g. library) with three personal computers (PCs) positioned in a way that the participant could only see their own screen. One, two or three participants could be tested at a time. The experiment environment had a glass panel which allowed the researcher to take observational notes

during their interaction. The PCs used had 256 Mb, 17'' cathode-ray tube (CRT) monitors that were calibrated to display the same colour values, contrast and brightness under the fluorescent light of the room.

3.3.1 Material and apparatus for Part 1

The first part simulated specific areas of a virtual learning environment (see Figure 6.1 for stimuli used). It used interactive software that simulated a VLE prototype that allowed the participants to navigate through the environment which was developed using the same set of pages from experiment 1 *Applying aesthetics* in two different layouts.

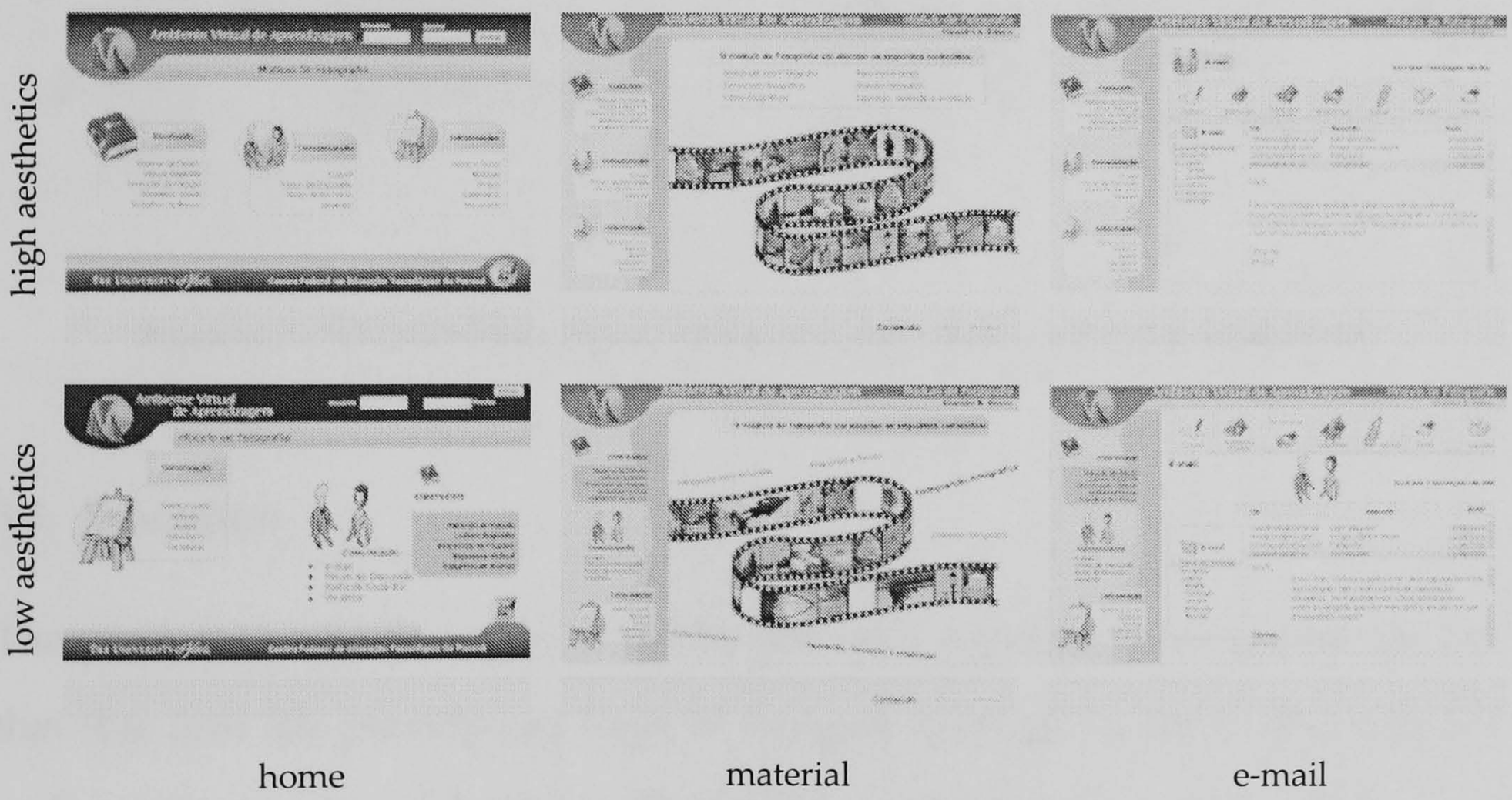


Figure 6.1: Examples of three sets of page *(home, material* and *e-mail)* and each one is represented in two distinctive layouts designs.

Each set of *pages* used the same graphic elements, colours and typography on two different layouts. One would follow all the design principles, called *high aesthetics* and the other, *low aesthetics*, would violate all of them (full material in Appendix 3).

3.3.2 Material and apparatus for Part 2

The second part showed the two different layouts, *high aesthetics* and *bad layout* from the *e-mail* set of pages on the same screen (Figure 6.2). The participants were able to compare them before choosing the one they perceived as more attractive and, on the following screen, the one they believed to be easier to use (Appendix 3).

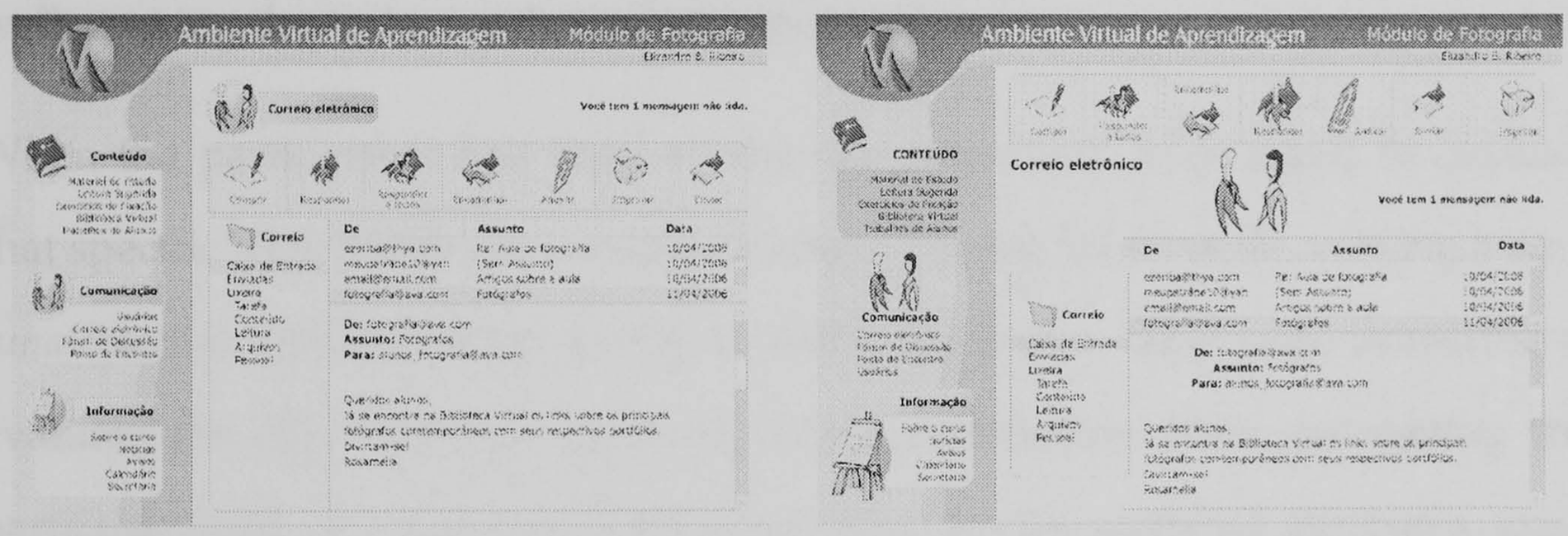


Figure 6.2 – Thumbnails of *screen A* (high aesthetics) and *screen B* (low aesthetics).

3.4 Procedure

The procedure was the same as for the previous experiment except for the fact that this time the participants have to navigate through an interactive interface and complete two tasks before evaluating the aesthetic and usability attributes of the environment used.

3.4.1 Procedure for Part 1

The experiment started by presenting the first set of pages, *home*, presented an introductory page of the module of photography and asked the participant for the login and password to enable them to proceed with the task and navigate to

the *e-mail* set of pages, where they received an e-mail asking a question that, in order to answer it, required them to navigate through the *material* set of pages where the content, a topic from black and white photography, presented a short introduction followed by seven examples of photography exemplifying different themes and composition. After that, they had to return to *e-mail* to give a reply with their answer. The two tasks were based on receiving and answering e-mails from friends and students. The main reason for this is because the e-mail is a well known and very common communication tool and the participants knew it quite well, making the tasks much more familiar to them.

When the participants had finished the two tasks they were asked to evaluate that specific VLE prototype condition using a 5-point Likert scale, varying from 1 *(unattractive)* to 5 *(attractive)* for the aesthetic attributes. They were instructed to evaluate the VLE focusing on their overall satisfaction when navigating this particular VLE. This process was then repeated for the usability attributes, using a 5-point Likert scale, ranging from 1 *(difficult to use)* to 5 *(easy to use)* and the evaluation would be based upon their judgement of how easy the environment was to use. They could spend as much time as they wanted to evaluate it and only when they clicked on the button (①, ②, ③, ④ or ⑤) to rate the interface would the screen change to the following question.

The VLE prototype navigation just presented one active link at a time to ensure that all the participants would follow the same path and see the same screens during the tasks. On the other side, it allowed the participants to go back and forth on the software during the navigation process as much as they liked before writing the answer. The answer could be changed as many times as they wished and just when the participant actually clicked on the send button would the task finish. The software did not allow the use of the 'copy-paste' feature to prevent the same answer being repeated many times instead of having a unique answer

for each participant. The format of the e-mail they had to write was open. In this way, it was possible to observe a variety of communication styles (e.g. formal or informal) and different ways of writing (e.g. just giving the answer or adding personality) using the same tool.

3.4.2 Procedure for Part 2

Part 2 was designed to check the participant's perception of aesthetics and usability when presented with two different layouts. It was introduced by an intermediary screen saying that they had finished both tasks. However, they would rate aesthetics and usability again by confronting them with the interface they had not seen before. This gave them the opportunity to judge by comparison *high aesthetics* against *low aesthetics*.

Participants were instructed to choose the one they would prefer (*screen A* or *screen B*) based on their impression of the best layout. The program ensured participants rated both aspects before finishing the computer experimental parts. They had to choose one of the screens by clicking on a button to move on to the next step. The program did not allow the participant to return to the previous screen as this would cause problems in recording and interpreting the data acquired.

4 RESULTS

4.1 Part 1: Aesthetics ratings

The aesthetics ratings of the interactive interface were analysed in a 2x2 between-subject ANOVA. The aesthetics manipulation had the expected effect with the two *high aesthetics* groups providing higher aesthetics ratings than the two *low aesthetics* groups. There appears to be a small effect of the usability manipulation but only for the *high aesthetics* but the interaction did not prove to be significant (see Figure 6.3).

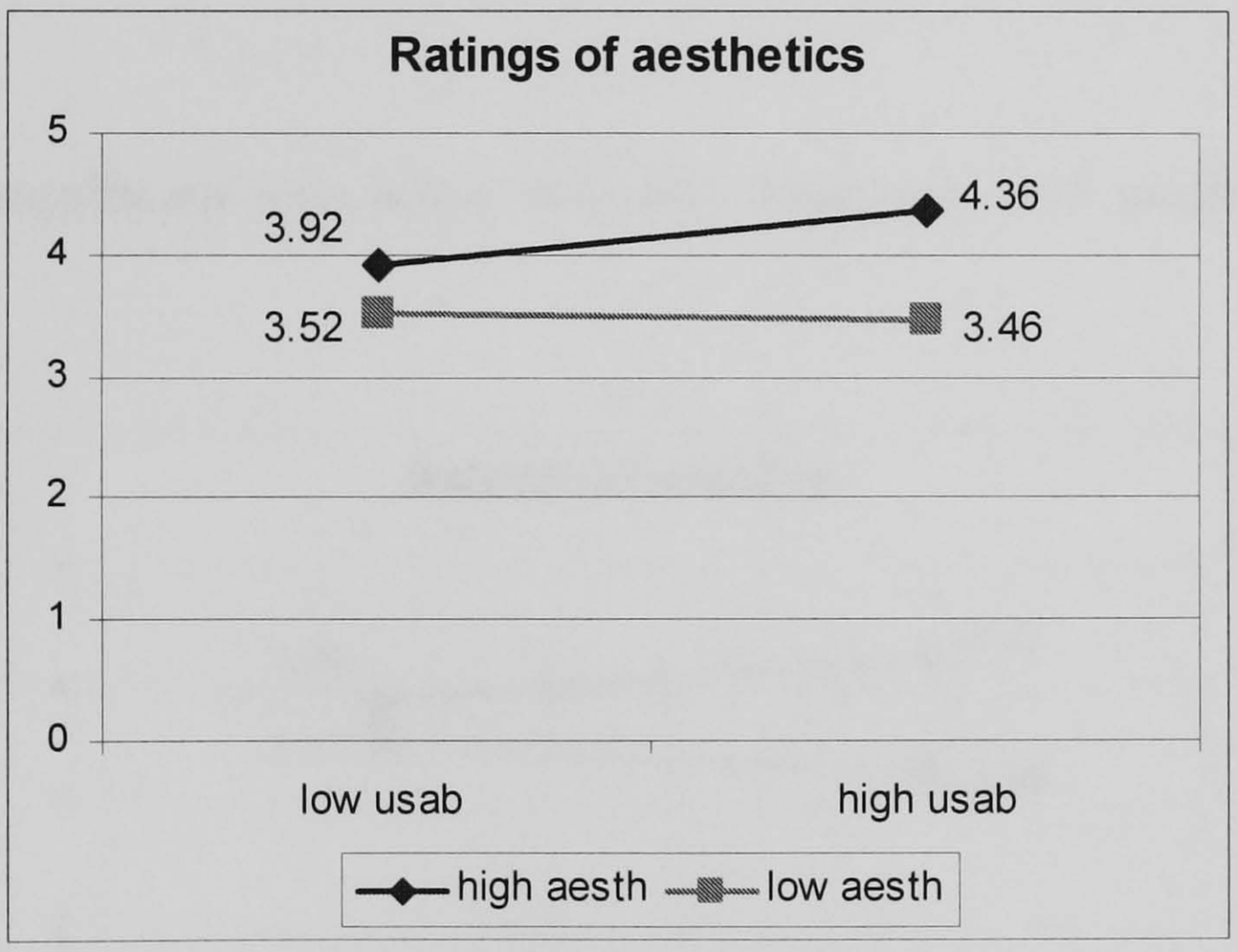


Figure 6.3: Aesthetics evaluation.

The 2-way between-subjects ANOVA revealed that the effect of the aesthetics manipulation was significant ($F_{(1,94)} = 9.459$, $p < .05$).

The main effect of the usability manipulation was not significant ($F_{(1,94)} = .838$, $p = .362$).

There was no significant interaction between aesthetics and usability ($F_{(1,94)} = 1.410$, $p = .238$).

4.1.1 Usability ratings

The usability ratings of the interactive interface were analysed in a 2x2 between-subject ANOVA. Figure 6.4 show the average of usability ratings considering the overall number of participants. These means show a very similar pattern of results to the manipulation of aesthetics above.

Again the 2-way between-subjects ANOVA revealed that the main effect of the aesthetics manipulation was significant ($F_{(1,94)} = 8.796$, $p < .05$).

The main effect of the usability manipulation was not significant ($F_{(1,94)} = .004$, $p = .949$).

There was no significant interaction between aesthetics and usability ($F_{(1,94)} = 1.802$, $p = .183$).

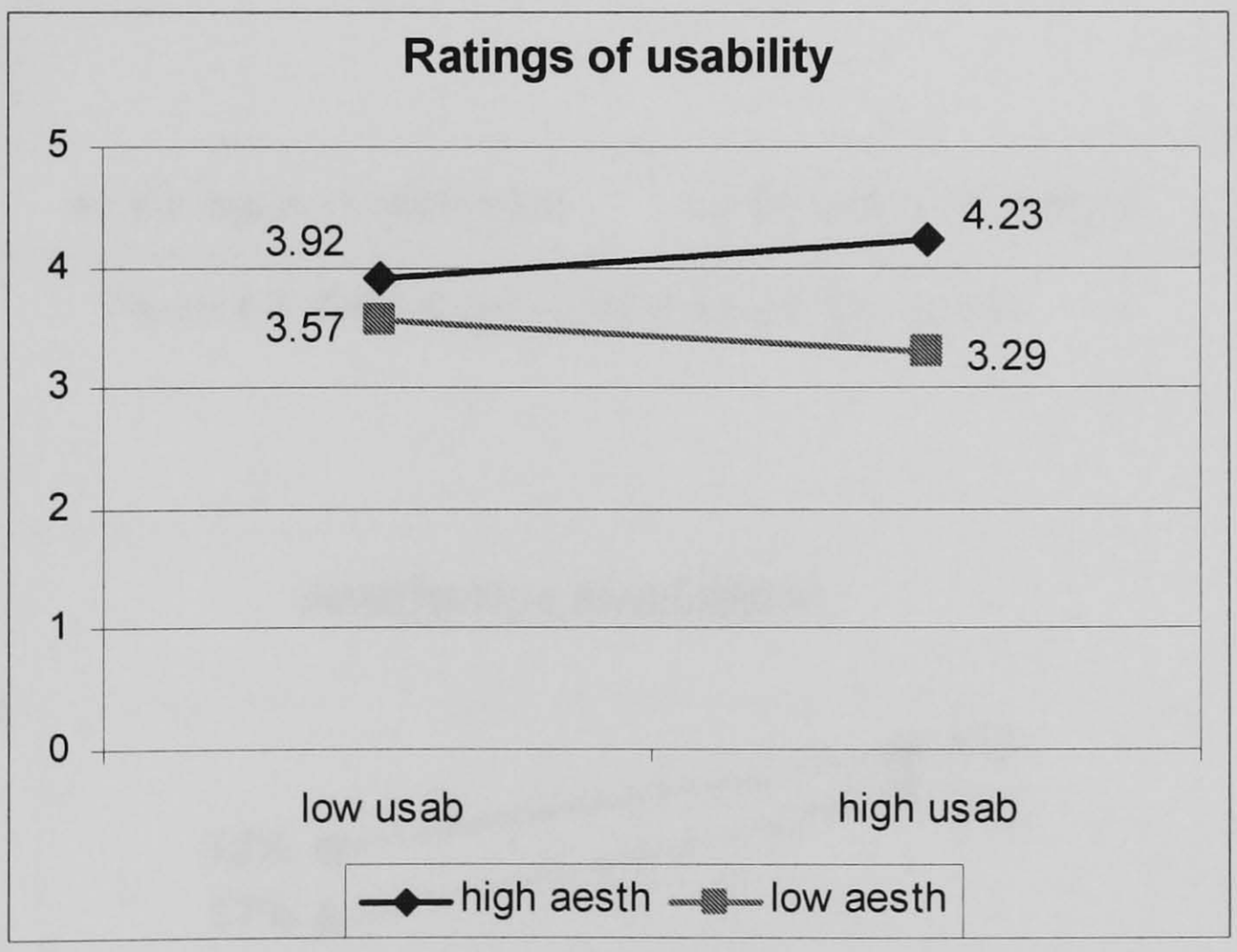


Figure 6.4: Usability evaluation.

4.2 Part 2: Two alternative forced choice

The importance of aesthetics and usability was tested through the participants' preference of *e-mail* sets of pages when comparing between two different screen

layouts, *high aesthetics* and *low aesthetics*. All four conditions evaluated the same screen layouts on their aesthetic and usability attributes. The participants' perception of aesthetics and usability when comparing the two different layouts are shown in Figures 6.5. It is possible to see the impact that the aesthetics attributes had over users' perception of usability with the *high aesthetics* layout being perceived to be easier to use.

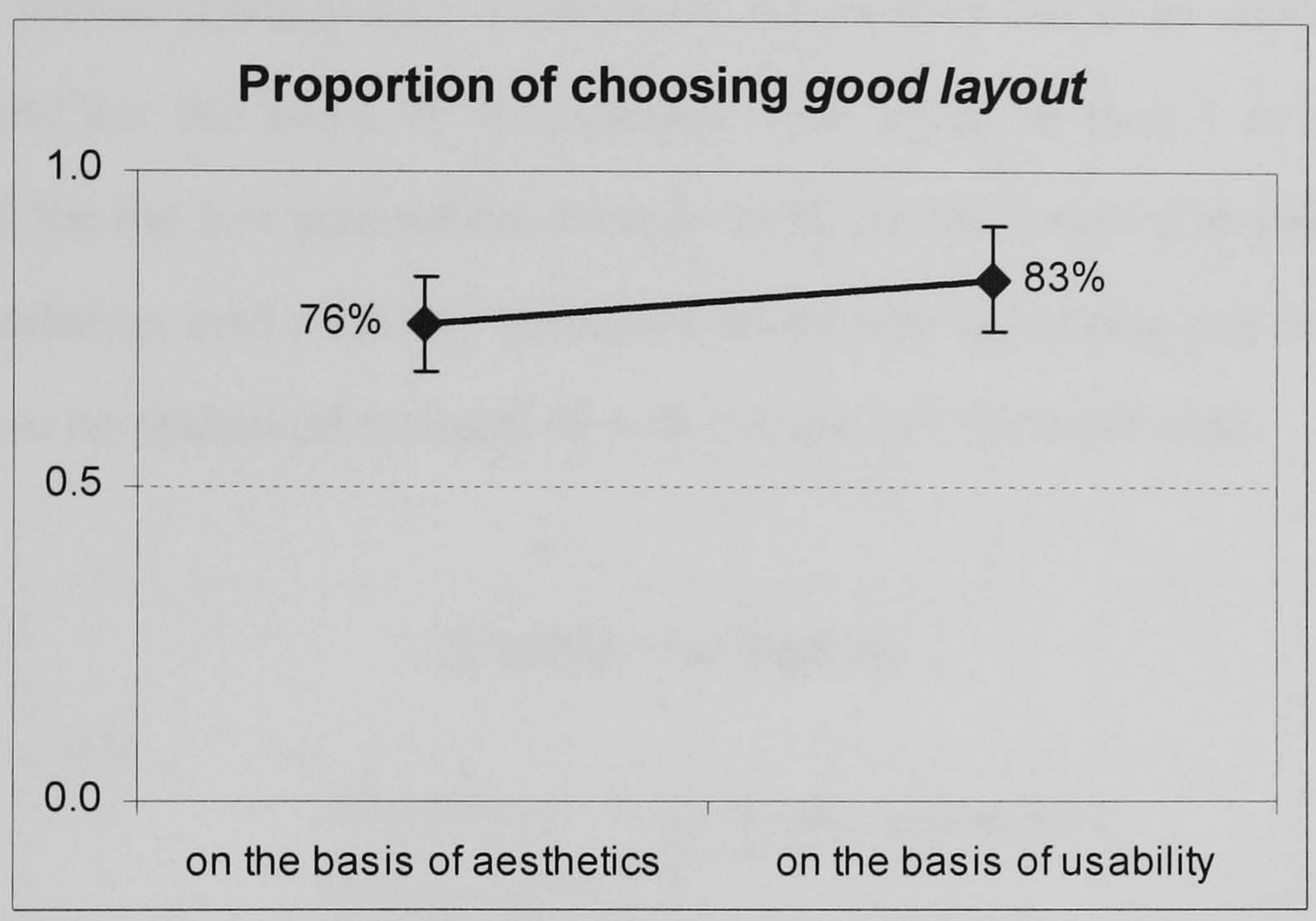


Figure 6.5: Participant's perception of best layout.

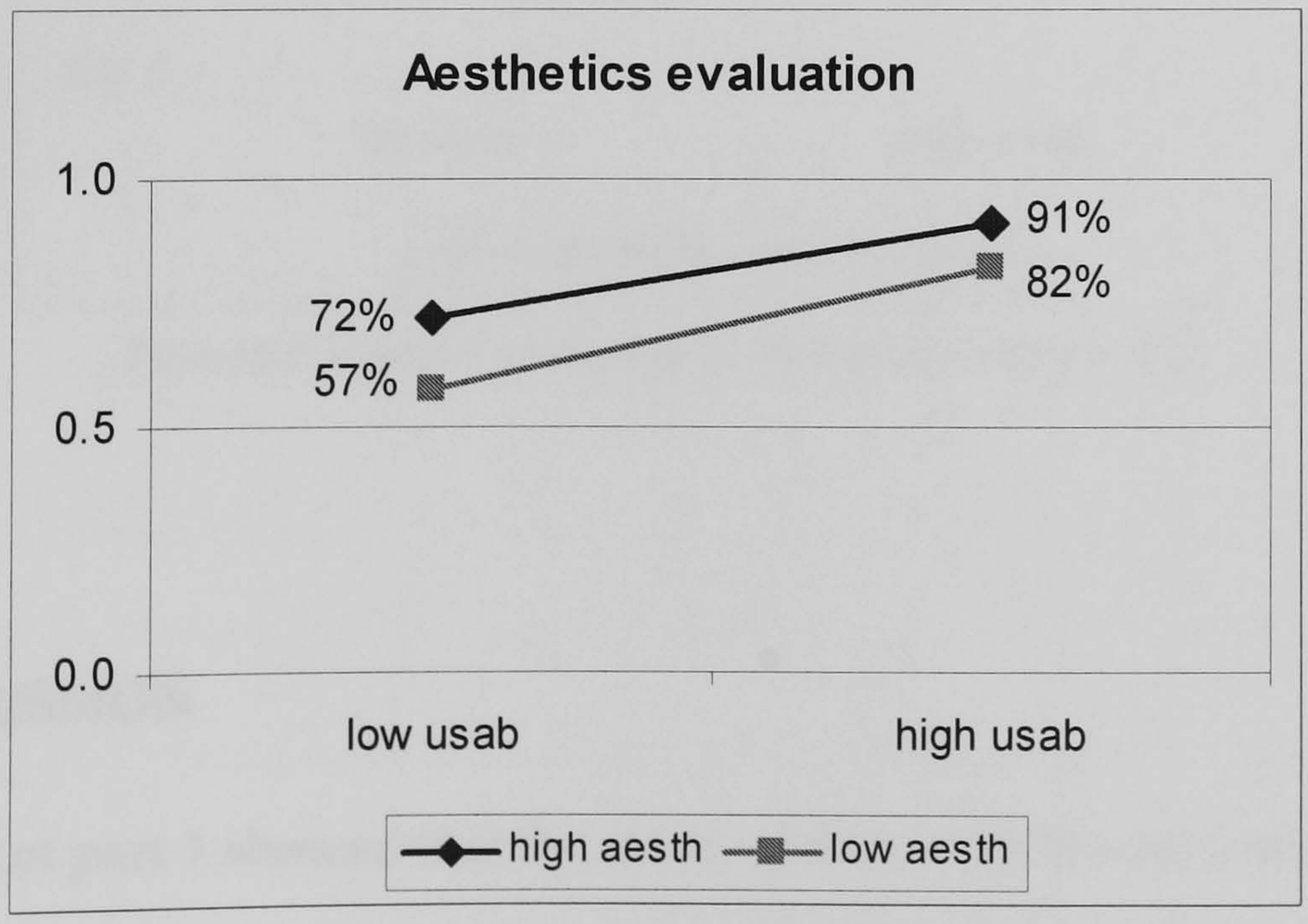


Figure 6.6: Aesthetics evaluation of the best layout for *e-mail*.

Figure 6.6 illustrates the proportion of participants who chose the best layout when asked to choose between *high aesthetics* and *low aesthetics* on the basis of screen aesthetics. It is apparent that part 1 of this experiment had affected the two alternative forced-choice decision. Participants who had the *high usability* condition chose the best layout more often than those who had the *low usability* condition.

Figure 6.7 shows participants' preference when they have to choose the best screen layout on the basis of its usability. The effect of Part 1 is less easy to understand for the two alternative forced-choice on the basis of usability. In both cases of aesthetics and usability decisions there was no strong pre-experimental prediction so no statistical evaluation was carried out on these data.

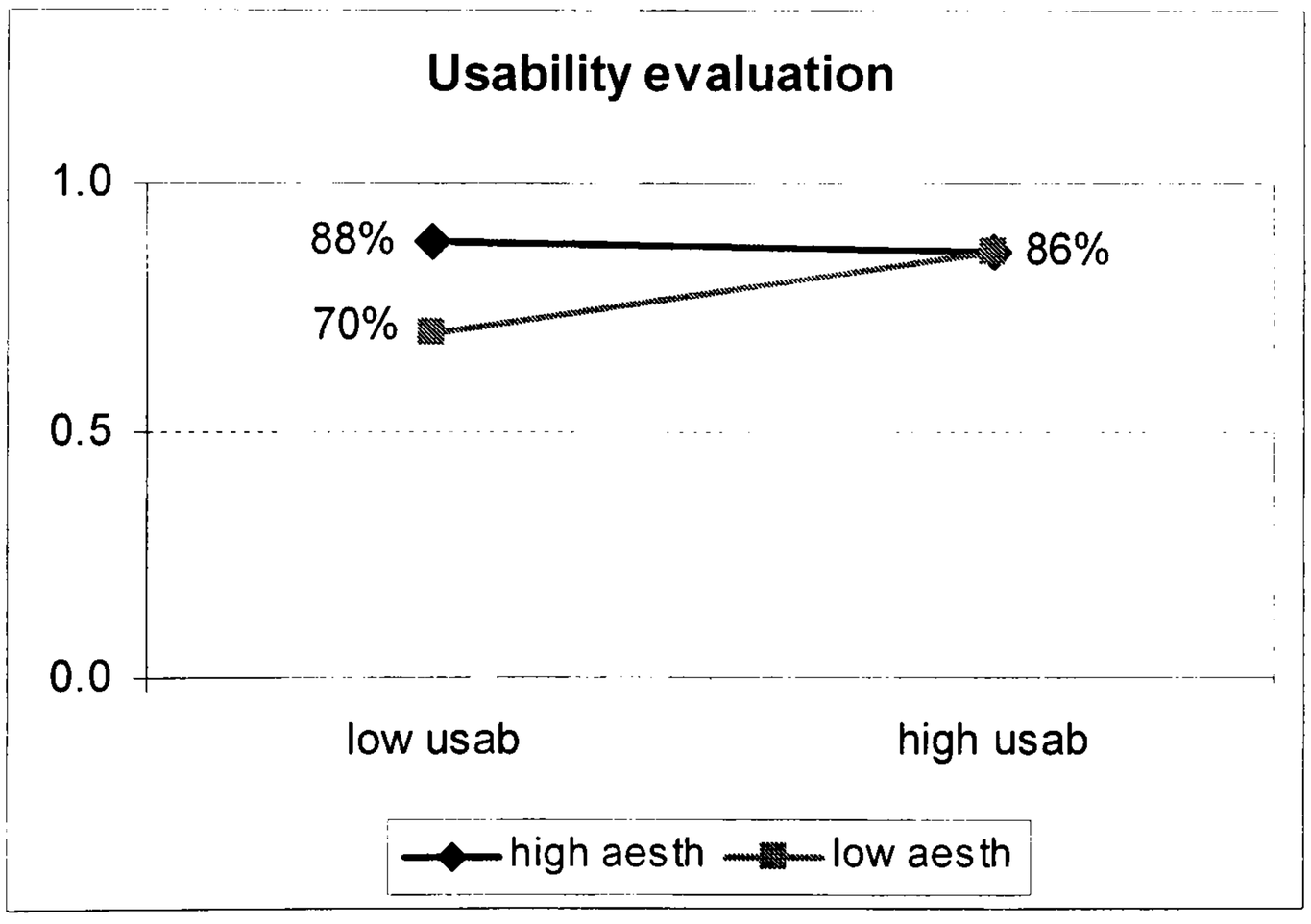


Figure 6.7: Usability evaluation of the best layout for *e-mail*.

5 DISCUSSION

The results of part 1 showed that the manipulation of aesthetics had an effect on both aesthetics and usability ratings, such that the results of a between-subject

ANOVA were statistically significant and similar for different conditions. On the other hand, the manipulation of usability had no effect on any of them. Also, the interaction of aesthetics and usability was not significant.

These findings are consistent with those in experiment 1, where the manipulation of aesthetics affected not only the ratings of aesthetics but the ratings of perceived usability as well. They gave evidence that aesthetic attributes c an strongly affect the way participants perceive the whole environment.

The results for the ratings of usability could be due to the fact that the manipulation of usability was not strong enough to be perceived by the participants, such as:

- the usability manipulation was made by inserting a 4s delay between different sets of pages and just one error message at the very beginning of the interaction;
- the participants could have thought that the low usability was due to hardware and the error message was a typing error;
- the participants expected some kind of usability problem, especially because it was an experimental prototype interface.

The results for similar aesthetics ratings on both groups, *high aesthetics* and *low aesthetics*, could also be because of a weak manipulation of aesthetics, which would not be enough for the interface to be perceived as non attractive, such as:

- the aesthetic manipulation was just in the middle of the page with heading and foot being the same in both conditions;
- the design of the screens used the same high quality graphical elements, colour and typography.

Another hypothesis could be that usability issues were not entirely understood by the participants; aesthetics is easier to be perceived and understood than usability.

Bearing in mind the results for aesthetics and usability ratings it is necessary to have another experiment with a stronger manipulation of the variables, aesthetics and usability. So, the findings from this experiment will be checked with another similar experiment to verify the results obtained and also to better understand the role that aesthetics play in the usability of interactive graphical interfaces.

Chapter 7

Experiment 3: Manipulating aesthetics and usability II

1 INTRODUCTION

Experiment 2, *Manipulating aesthetics and usability I,* tried to replicate the results that Tractinsky (2000) found with an interactive ATM (Automatic Teller Machine). It used an interactive VLE interface and found a positive relationship between aesthetics and usability attributes of the interface.

The study used an interactive VLE interface and rated the aesthetics and usability attributes after the user had navigated through the environment to complete two tasks. The aesthetics manipulation had a noticeable effect on the aesthetics and usability ratings. However, the usability manipulation showed no effect on rating aesthetics or usability attributes. These results suggested that the manipulation of usability was not strong enough to be perceived by the participant and needed to be confirmed with another experiment.

The present study aims to: (i) confirm the results from the previous experiment *Manipulating aesthetics and usability I,* and (ii) verify if the results would show any differences with a stronger manipulation of aesthetics and usability attributes.

The stimuli material used for this experiment was an interactive prototype which simulated specific areas of a VLE prototype that allowed the participants to navigate through the environment, which was developed using the same set of pages *home, material* and *e-mail* from the previous experiment. However, the

aesthetics manipulation was made more apparent to the participant and usability had stronger manipulation with additional error messages and increased the delay time between each set of pages.

Also this time there was the additional feature of a *training* interface. This was developed in a similar way to the measured interface but designed in a very different graphical style. The purpose of the *training* interface was to allow the participants to get familiar with the environment of an online course before using and evaluating the *measured* interface prototype.

Like the previous experiment the participants had to interact with the environment, performing two tasks, before evaluating the aesthetics and usability attributes of the interface.

2 INTRODUCTION TO THE EXPERIMENT

This experiment replicated part 1 and part 2 from the previous experiment. In addition to that, it used another software prototype designed to work as a *training* interface where the participants could navigate and get a first exposure to this type of environment and task before getting into the experiment itself. This helped them to give a more accurate rating that would reflected the participants' correct understanding of the variables, *aesthetics* and *usability*, in question.

Like experiment 2, the first part aimed at the evaluation of the aesthetics and usability attributes of the interface after navigating through the VLE prototype to complete two tasks. The second part collected data on the attractiveness and ease of use of the interface by comparing the page *e-mail* in both layout conditions (*high aesthetics* and *low aesthetics*).

In part 1 the participants have to complete two tasks. They received instructions about their role through verbal explanation before starting the experiment and during the interaction they had an intermediary screen guiding them throughout the tasks. In the first task the participants played the role of a student enrolled in that module who receives an *e-mail* from a colleague asking his opinion on a particular matter. They had to navigate through the course *material* pages to be able to reply to their friend's e-mail. For the second task the participant's role changed and now they are the course tutor, who has received an e-mail from a group of students asking about the module program for week six and also, the amount of time given to cover one specific topic. The 'tutor' needed to navigate through the course information pages *calendar* to find the answer and reply to the students.

The aesthetic attributes had two different sets of pages, one that had all the design principles applied *(high aesthetics)* and the other that violated all of them *(low aesthetics)*. The manipulation of aesthetics was stronger for the *low aesthetics* condition with the graphic elements being distorted and the text positioned in a more unconventional way violating the principles of unity, proportion, homogeneity, rhythm and balance further than had been done in study 2. The usability attributes had two levels, one with several error messages and 6s delay between different sets of pages and *(low usability)* and the other without error message or delays *(high usability)*. The usability manipulation was stronger for the *low usability* condition than it was for experiment 2, which had a 4s delay between different set of pages and just one error message at the beginning of the interaction. The 6s delay occurred between screens, even on the instructions screens. However, during the navigation into the same set of pages such as, the *material* content and *calendar*, it did not have any delay. The four different

conditions generated by aesthetics and usability manipulation are presented in Table 1.

Table 7.1: Experimental conditions.

		Aesthetics	
		High	Low
Usability	Low	Group 1 (1A)	Group 3 (2A)
	High	Group 2 (1B)	Group 4 (2B)

2.1 Part 1

The program simulating a prototype of a virtual learning environment was similar to the one used in experiment 2. It used three sets of pages *home*, *material* and *e-mail*, each one presented in two aesthetic manipulations, one that applies all the design principles, called *high aesthetics* and another that violates all of them, called *low aesthetics* (Figure 7.1). The usability manipulation also had two levels, *high usability* (no delays or error messages) and *low usability* (6s delay and several error messages).

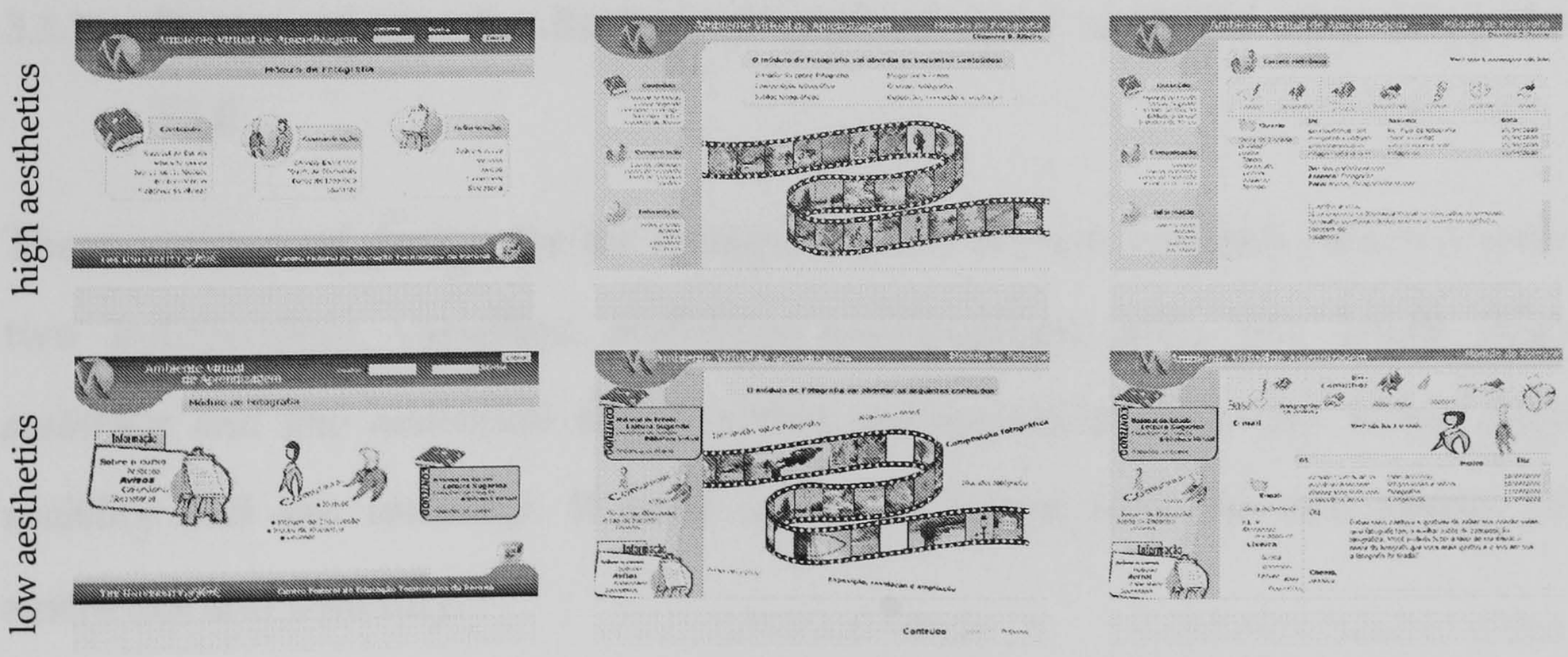


Figure 7.1: Examples of three sets of pages (*home, material* and *e-mail*) each one of which is represented in two distinctive layout designs.

2.2 Part 2

The second part of the experiment intended to re-evaluate the aesthetics and usability attributes of the used VLE prototype used. Each participant, independent of the group assigned, was asked to choose the layout they liked best and then the one they believed to be easier to use based on the *e-mail* page.

The different layouts were presented together as shown in Figure 7.2.

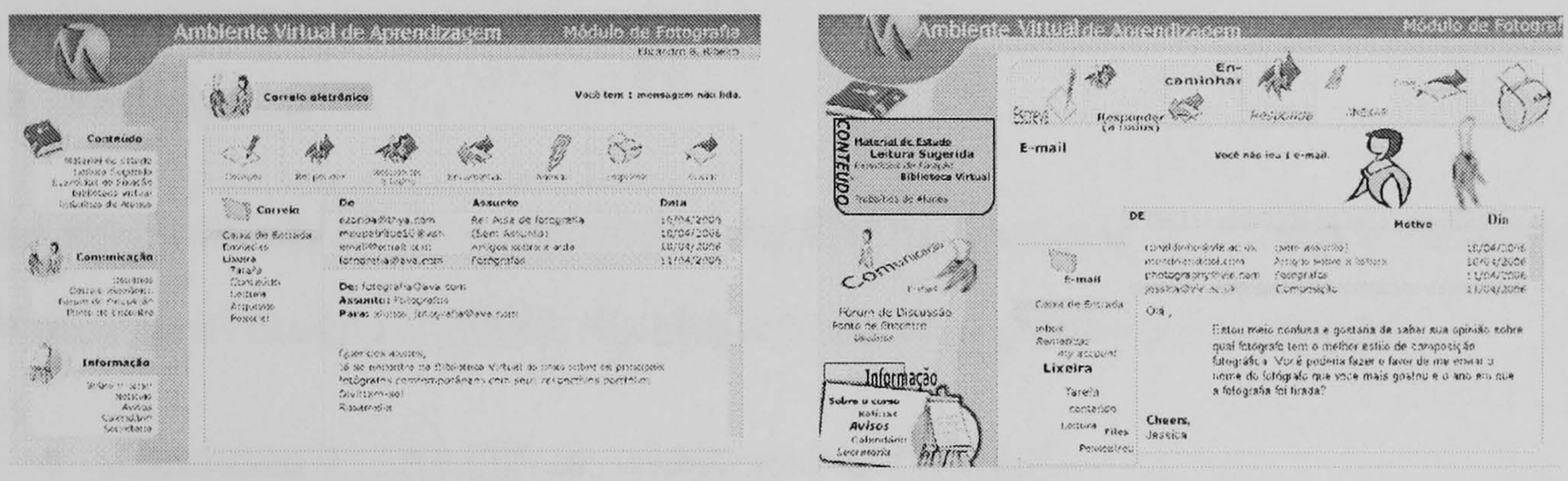


Figure 7.2 – Thumbnails of *screen A* (high aesthetics) and *screen B* (low aesthetics).

3 METHOD

3.1 Design of the experiment

3.1.1 Design of part 1 – Ratings of aesthetics and usability after using the VLE

The experimental design for the ratings was 2x2 between-subject ANOVA with two independent variables: aesthetics manipulation with two levels *(high aesthetics and low aesthetics)* and usability manipulation with two levels *(high usability and low usability)*. It used a 5-point Likert scale for the ratings of aesthetics and usability.

3.1.2 Design of part 2 – Two alternative forced-choice

Like the previous experiment this also was a simple choice between two screens performed twice, once for their preference on the basis of aesthetics and another for usability attributes. The experimental design was a between-subject with two independent variables: aesthetics manipulation with two levels *(high aesthetics and low aesthetics)* and usability manipulation with two levels *(high usability and low usability)*.

3.2 Participants

The study involved 88 participants enrolled or working at a Higher Education Institution in Brazil (UTFPR), distributed into four different conditions.

- Condition 1 (1A): (22; 11 males and 11 females);
- Condition 2 (1B): (22; 12 males and 10 females);
- Condition 3 (2A): (22; 13 males and 9 females);
- Condition 4 (2B): (22; 13 males and 9 females);

The mean age was 28. Ages ranged from 17 to 57 years old. Overall there were 49 males and 39 females.

3.3 Material and apparatus

This experiment used the same physical environment used by the previous experiment. The room layout was kept identical and used the same three personal computers (PCs). As before, there could be one or three participants doing the experiment at the same time.

The same interactive VLE interface as experiment 2 was used. However, this time the participant had another VLE interface to interact with before using the

proposed VLE prototype. This *training* interface allowed the participant to have a better idea about the nature of a VLE. It had similar tasks and ratings to be completed, although in a different graphic style (square) and it used different shades of green (see Appendix 6). This *training* interface was developed with two different aesthetic manipulation levels, *high aesthetics* and *low aesthetics* which violate all design principles and just one level of usability manipulation, *medium usability* (just 3s delay between different sets of pages, receiving feedback messages and several error messages). Like the *training* interface the *measured* interface had two levels of aesthetics manipulation, *high aesthetics* when the screen layout follows all the design principles and *low aesthetics* when the screen layout violates all the design principles. However, the usability manipulation for the *measured* interface had two levels, *high usability* when there were no delays or error messages and *low usability* when there were 6s delays when navigating between different sets of pages, receiving feedback messages and several error messages (login in and clicking on inactive links)

Addition material was provided to give feedback to those who had participated in the previous experiment. A fully illustrated coloured A_5 flyer was developed to show the participants the main purpose of the study and the results from the first experiment, which had taken place one year before and whose results had already been published at conferences at that time (see Appendix 5). This type of feedback was very well received by the participants and also gave a better overview of the research. It also reinforced the commitment with the participants' contribution and gave greater credibility to the research being done.

3.3.1 Material and apparatus for Part 1

The first part simulated specific areas of a virtual learning environment (see Figure 7.1 for stimuli used). It used an interactive software that simulated a VLE

prototype that allowed the participants to navigate through the environment, which was developed using the same set of pages from the previous experiment in two different screen layouts (full experimental material on Appendix 4).

Each set of pages was composed of two different layouts. One would follow all the design principles, called *high aesthetics* and another, *low aesthetics*, would violate all of them. The usability manipulation was presented in two levels: one without delays and error messages, called *high usability*, and another with 4s delay between different sets of pages and several error messages, called *low usability*.

3.3.2 Material and apparatus for Part 2

The second part showed the two different layouts, *good layout* and *bad layout* from the set of pages *e-mail* in the same screen. The participants were able to compare them before choosing the one they perceived as more attractive and, on the next screen, the one the believed to be easier to use (full material on Appendix 4).

3.4 Procedure

The procedure was the same as for the previous experiment except for the fact that this time the participants started this experiment with the *training* interface. They had to perform two tasks and at the end of them were asked to evaluate its aesthetics and usability attributes. It was developed in the same navigational style and had a similar task as the *measured* interface with two different aesthetic manipulation levels, *high aesthetics* and *low aesthetics* and one level of usability manipulation, *medium usability* (3s delay between different sets of pages and several error messages). All the participants would use the same *training* interface independent of the condition assigned for the *measured* task.

The *training* interface allowed the participant to have a better idea about the nature of a VLE, get used to the physical environment (e.g. mouse, chair, lights, etc) as well as level their anxiety towards the experiment so that when they were presented with the *measured* interface they were familiar with that environment.

3.4.1 Procedure for Part 1

The experiment started by presenting the first set of pages *(home)* showing an introductory page of the module on Photography, asked for the login and password to enable the participant to proceed with the task and navigate to the *e-mail* page. At this point they received an e-mail asking a question which required them to navigate through the *material* set of pages. There were seven examples of black&white photography exemplifying different themes and compositional styles with a short explanation. After that, they had to return to *e-mail* to reply to it with their answer. The two tasks were based on receiving and answering e-mails from friends and students. The main reason for this is because e-mail is a well known and very common communication tool and the participants knew it quite well, making the tasks very familiar to them.

When the participants had finished the two tasks they were asked to evaluate the VLE prototype in question using a 5-point Likert scale, varying from 1 *(unattractive)* to 5 *(attractive)* for the aesthetic attributes. They were instructed to evaluate the VLE focusing on their satisfaction when navigating this particular VLE. This process was then repeated for the usability attribute, using a 5-point Likert scale, ranging from 1 *(difficult to use)* to 5 *(easy to use)* and the evaluation would be based upon their judgement of how easy the environment was to use. They could spend as much time as they wanted to evaluate it and only when they clicked on the button (①, ②, ③, ④ or ⑤) to rate the interface would the screen change to the next one.

The navigation of the VLE prototype just presented one active link at a time to ensure that all the participants would follow the same path and see the same screens during the tasks. On the other side, it allowed the participants to go back and forth on the software during the navigation process as much as they liked before giving their answer. The answer could be changed as many times as they wished and only when the participant actually clicked on the send button would the task finish. The software did not allow the use of the 'copy-paste' feature to prevent the same answer being repeated many times instead of having a unique answer for each participant. The format of the e-mail they had to write was free. In this way, it was possible to observe a variety of communication styles (e.g. formal or informal) and different ways of writing (e.g. just giving the answer or adding personality) using the same tool.

3.4.2 Procedure for Part 2

Part 2 was designed to check the participant's perception of aesthetics and usability attributes when presented with two different layouts. The task was introduced by an intermediary screen saying that they had finished the tasks. However, they would rate aesthetics and usability attributes again by confronting them with an interface they had not seem before.

Participants were instructed to choose the screen they would prefer *(screen A or screen B)* based on their impression of the best layout. They would click on a button to choose *screen A* or *screen B*, then they were asked to choose the screen they believed to be easier to use *(screen A or screen B)*.

The program ensured participants rated both aspects before finishing the computer experimental parts. They have to choose one of the screens to move on to the next step. It was not possible to return to the previous screen as this would cause problems in recording and interpreting the data acquired.

Table 7.2 shows the average time the participants spent navigating on the *measured* interface to complete the experiment on each one of the four conditions.

Table 7.2: Average time to complete each condition.

Group	Average time spent (min)
Group 1A (high aesthetics/low usability)	09 min
Group 1B (high aesthetics/high usability)	09 min
Group 2A (low aesthetics/low usability)	08 min
Group 2B (low aesthetics/high usability)	07 min
Total average	08 min

The time to perform the task was identical for the *high aesthetics* conditions (9 mins), independent of its usability. For the *low aesthetics* condition the time to complete the task was lower, especially for *high usability* (7 mins).

The participants who took the low aesthetics condition made some comments regarding the interface design. They said that they did not enjoy using it at all. Also, they said that they did not want to spend a lot of time interacting with an unattractive environment and wanted to finish quite fast.

The results from the average time spent navigating through the environment show that the participants who took the low aesthetics condition (groups 2A and 2B) spent less time completing the experiment than those who took the high aesthetics condition (groups 1A and 1B). Group 2B spent 1 min less than group 2A, showing that the usability manipulation had an effect on the interaction, slowing the users. Interestingly enough, the condition where the layout was unattractive but presented no delays was completed in less time than the others, supporting the participants' comments and suggesting that aesthetic attributes influence the users' attitude towards the interface.

4 RESULTS

4.1 Part 1: Aesthetics and usability ratings

The aesthetics and usability ratings were analysed in a 2-way between subject ANOVA. The stronger manipulation of aesthetics and usability appeared to have produced the desired effect and the users could perceive the difference between attractive and unattractive interfaces as well as the difference between easy and difficult to use.

4.1.1 Aesthetics ratings

The aesthetics manipulation had the expected effect with the two *high aesthetics* groups providing higher aesthetics ratings than the two *low aesthetics* groups (see Figure 7.3). The aesthetics ratings were similar to experiment 2. The stronger manipulation of aesthetics had the expected result with an even larger effect of aesthetics than the one found in experiment 2.

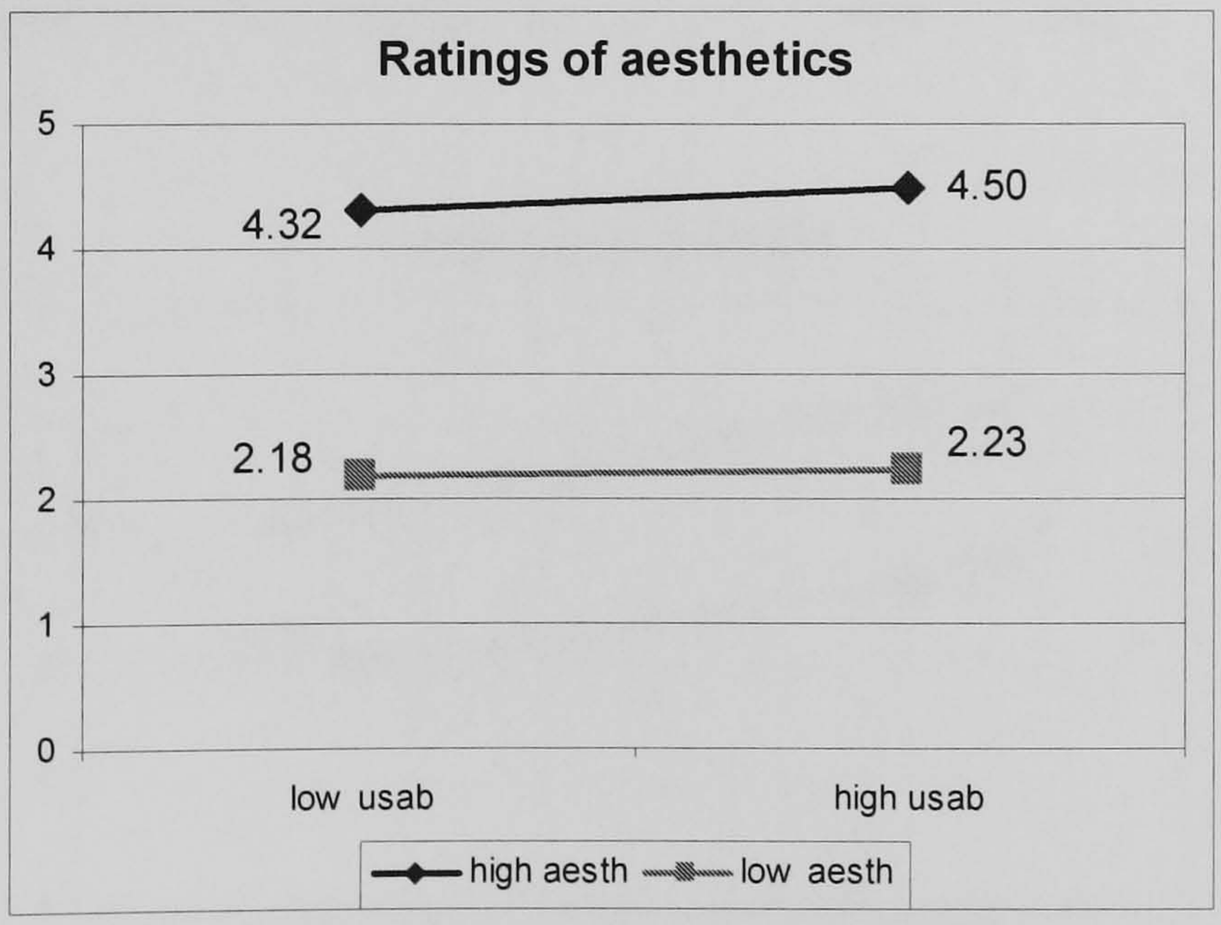


Figure 7.3: Evaluation of the aesthetics manipulation.

The 2 way between-subject ANOVA revealed that the main effect of aesthetics manipulation was significant $F_{(1,84)} = 111.356$, $p < .05$), indicating a massive effect of aesthetics on the user perception of interface attractiveness.

The main effect of the usability manipulation was not significant ($F_{(1,84)} = .435$ $p = .511$).

There was no significant interaction between aesthetics and usability ($F_{(1,84)} = 193$, $p = .661$).

4.1.2 Usability ratings

The usability ratings of the interactive interface were analysed in a 2x2 between-subject ANOVA and are illustrated in Figure 7.4. The interface with high usability and low aesthetics condition has a lower mean for usability rating than the interface with low usability and high aesthetics condition.

The 2-way between-subjects ANOVA revealed that the main effect of the aesthetics manipulation was significant ($F_{(1,84)} = 32.084$, $p < .05$).

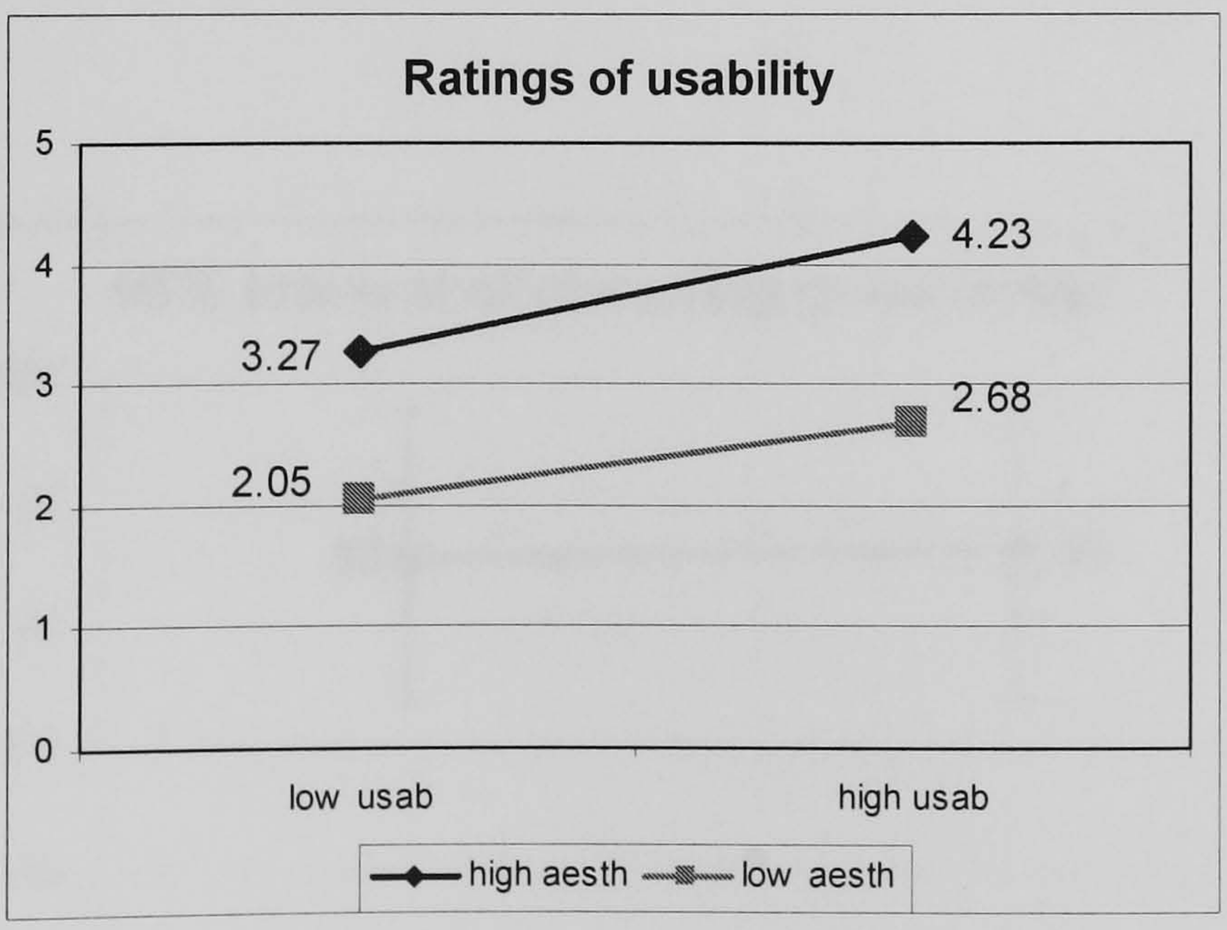


Figure 7.4: Evaluation of the usability evaluation.

The main effect of the usability manipulation was significant ($F_{(1,84)} = 9.649$, $p < .05$), indicating that the manipulation was successful and the participants perceived the difference between easy and difficult to use.

There was no significant interaction between aesthetics and usability $F_{(1,84)} = .300$, $p = .585$).

The changes to the procedure were successful, so that the main effect of usability was significant. However, the size effect of the usability manipulation is quite small ($F_{(1,84)} = 9.649$, $p < .05$) compared with the one obtained with the aesthetics manipulation ($F_{(1,84)} = 32.084$, $p < .05$).

4.2 Part 2: Two alternative forced choice

The importance of aesthetics and usability attributes was tested through the participants' preference for *e-mail* sets of pages when comparing between two different screen layouts, *high aesthetics* and *low aesthetics*. All four conditions evaluated the same screen layouts. The participants' perception of aesthetics and usability attributes when comparing between the two different layouts is shown in Figures 7.5.

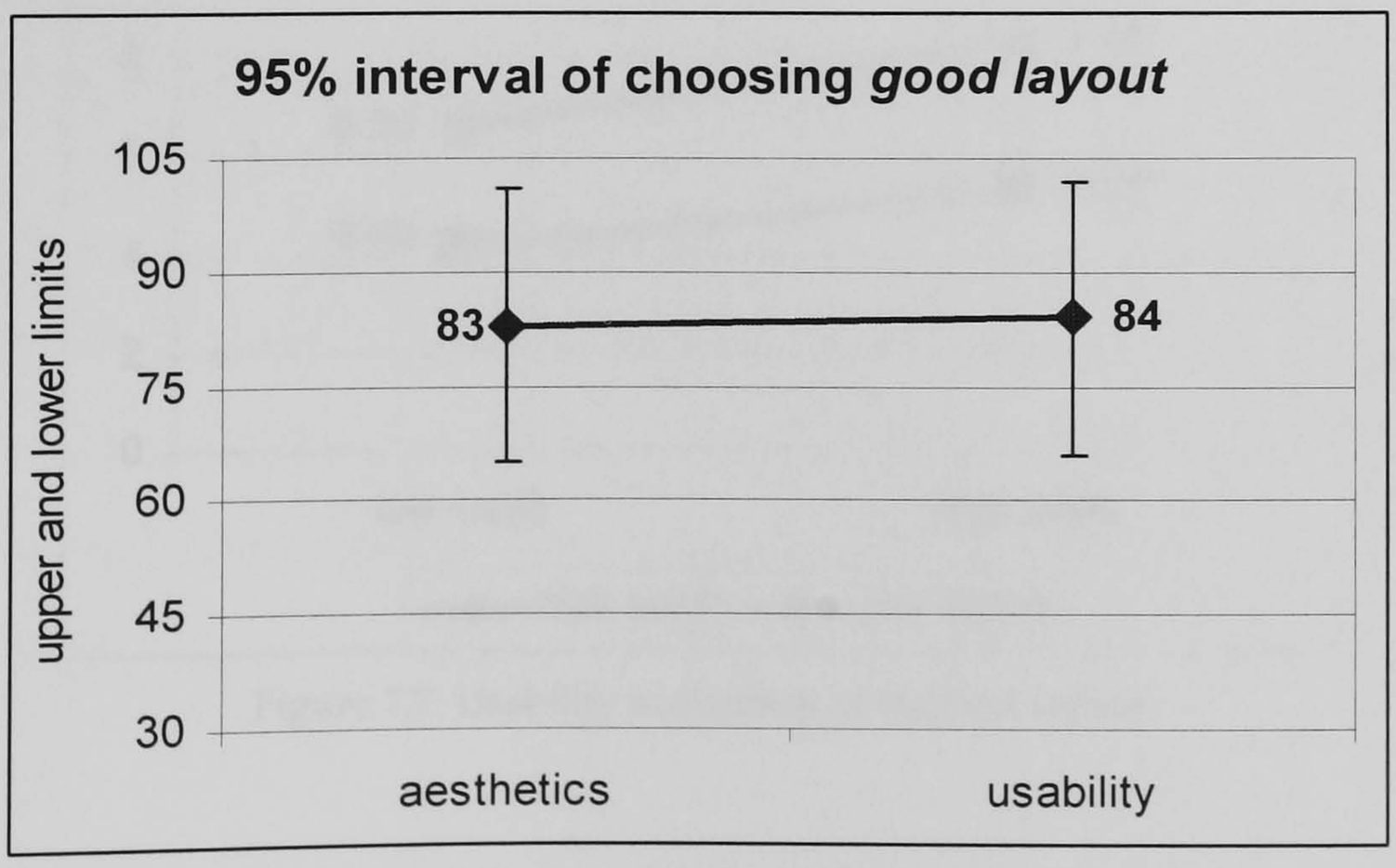


Figure 7.5: Participants' evaluation of the best layout.

Figure 7.6 illustrates the proportion of participants who chose the best layout when asked to choose between *high aesthetics* and *low aesthetics* on the basis of screen Aesthetics.

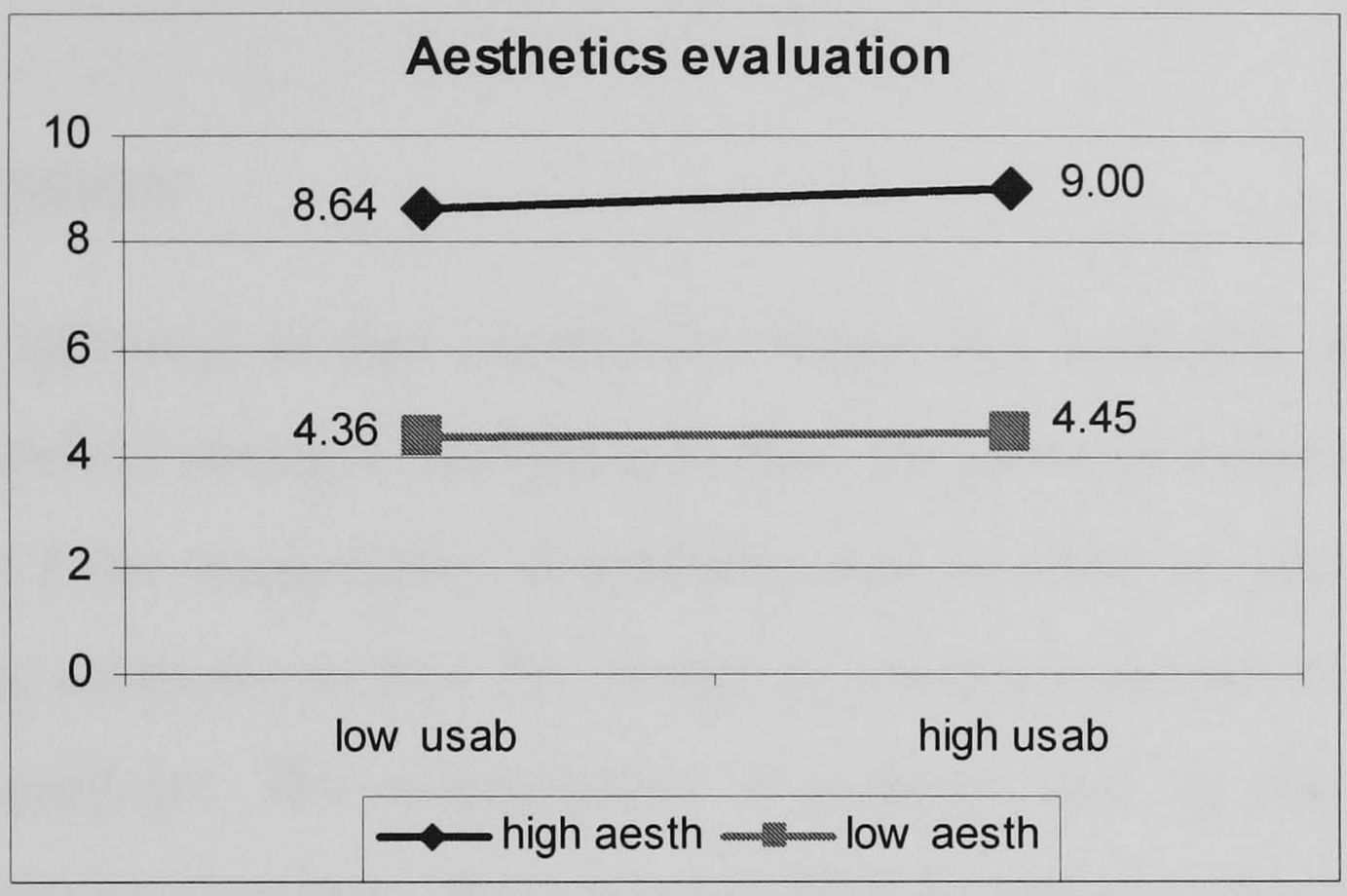


Figure 7.6: Aesthetics evaluation of the best layout.

Figure 7.7 shows participants' preference when they have to choose the best screen layout on the basis of its usability.

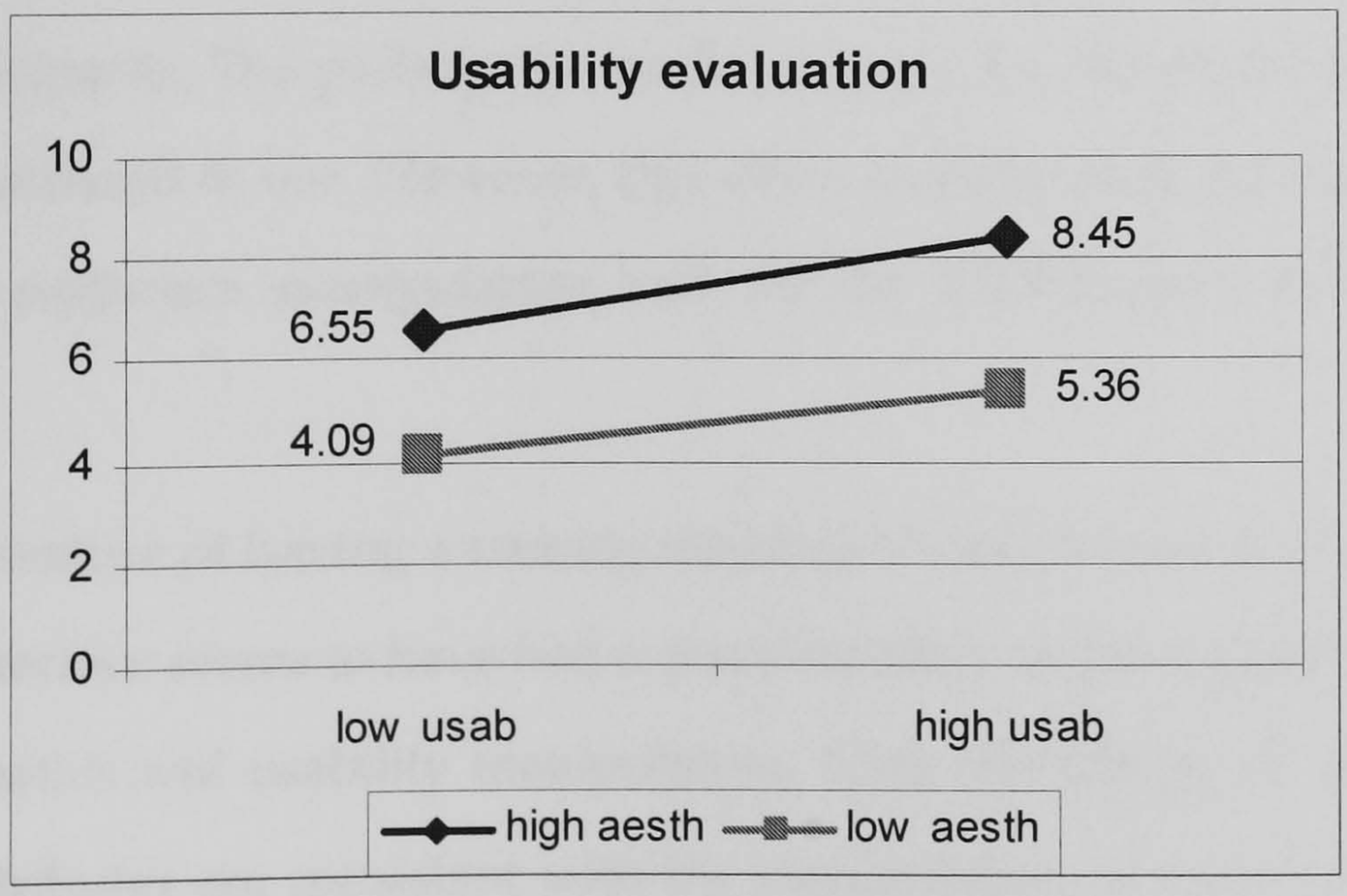


Figure 7.7: Usability evaluation of the best layout.

The effect of the previous experiment is less easy to understand for the two alternative forced-choice on the basis of usability. In both cases of aesthetics and usability decisions there were no strong pre-experimental predictions so no statistical evaluation was carried out on these data

5 DISCUSSION

The results obtained in this experiment, where the aesthetics and usability attributes received stronger manipulation than the previous experiment, shows that for part 1 the manipulation of aesthetics had an effect on rating aesthetics and usability attributes so that the results of a between-subject ANOVA were statistical significant. The manipulation of usability had an effect on rating usability attributes; however, there was no effect on rating aesthetics attributes. In both cases there was no significant interaction between aesthetics and usability ratings.

The results for the usability manipulation are consistent with the hypotheses from experiment 2 that a stronger manipulation of usability would be perceived by the participants. The participants could perceive the difference between easy to use and difficult to use. However, this effect is quite small if compared to the effect that aesthetics manipulation had on the participants' opinion of the interface.

The added feature of having a *training* interface to interact with before using the *measured* interface seems to have had a positive effect on participants' perception of the aesthetics and usability manipulation. Also, the ratings of aesthetics and usability attributes are consistent with the manipulation of each one of the four conditions.

The two alternative forced-choice shows that the user has a strong sense of aesthetics when given the opportunity to examine good screen layout against bad screen layout. This result is independent of the condition assigned for the main part of the experiment. Also, the perception of aesthetics influences the users' perception of usability.

The findings of this experiment confirm previous findings where aesthetic attributes of an interface affect the perception of its usability. However, there will be another experiment to check if these results are not influenced by the rating order, which was kept the same throughout experiments 2 and 3.

This experiment shows a major effect of aesthetics manipulation on the aesthetic attributes and also on the usability attributes. This effect of aesthetics could be because of the order of rating, which was designed to rate first the aesthetic and then the usability attributes.

Another experiment needs to be carried out. It needs to go to some length to de-emphasise the aesthetic qualities of the interface and also consider if the order of rating has had an influence on the way participants rated the aesthetics and usability attributes.

Chapter 8

Experiment 4: Manipulating aesthetics and usability III

1 INTRODUCTION

Experiments 2 and 3 used a Virtual Learning Environment prototype, where the participants navigated through the interface in order to complete two tasks, to evaluate the interface aesthetics and usability attributes. They showed that aesthetic attributes have a massive effect on the way the participants perceive the usability of an interactive interface. However, the order of rating of the aesthetics and usability attributes was kept the same in both experiments and the aesthetic attributes was always rated prior to the usability attributes.

Therefore, the purpose of this experiment is to check for any effect that the order of rating could have on the participants' ratings of the aesthetics and the usability attributes. It considered three different designs to evaluate a possible rating order effect.

First, a simple design was considered to rate the usability manipulation only, so that the participant evaluation would not suffer any contamination from the aesthetics manipulation.

The second alternative was to split each one of the four conditions into two different rating orders and evaluate both variables. One group would rate the aesthetics manipulation first followed by the usability manipulation. The second

group would have the same condition evaluated using the opposite order, first usability manipulation then aesthetics manipulation.

Third, a design was considered where the participant would evaluate one of the two variables twice. This also means that, like the second alternative, each condition was split into two different orders of ratings. One group would rate the aesthetics manipulation first, then the usability manipulation and again aesthetics. The other group, assigned for the same experimental condition, would rate the usability manipulation first, then aesthetics manipulation and usability manipulation again.

The reason this third design was chosen was to verify if the participants' ratings would change when rating one of the variables for the second time. It also made it possible to check if one variable would have any contamination over another.

So, as the main goal for this fourth and last experiment was to verify the results obtained with experiments 2 and 3 and it used the same measured interface as that in experiment 3. The *training* interface suffers one change in its usability manipulation, which this time also had 2 levels *(high* and *low usability)* like the aesthetics manipulation *(high* and *low aesthetics).*

2 INTRODUCTION TO THE EXPERIMENT

This experiment was very similar to experiment 3. The first part intended to evaluate the aesthetic and usability attributes of the interface after navigating through the VLE prototype software to complete two tasks. The second part was designed to collect data on the attractiveness and usability of the interface by comparing the page *e-mail* in both layout conditions *(high aesthetics* and *low aesthetics).*

The main difference of this experiment from experiment 3 was that this time a third variable was introduced, the order of rating. This means that each condition was divided into two groups, each one with a different order to evaluate the aesthetics and the usability attributes.

In addition to this the *training* interface instead of having a *medium usability* (3s delay between different sets of pages and several error messages throughout the interface) now had two usability levels like the *measured* interface. The *high usability* level had no delays or error messages and the *low usability* level had a 6s delay between different sets of pages and several error messages.

Part 1 was composed of the *training* and the *measured* VLE interfaces. The *training* interface was the same used in experiment 3 where the participants could navigate and get a first exposure to this type of environment and task before getting into the experiment itself. The *measured* interface was also the same used in experiment 3 where the participants were asked to complete two tasks before evaluating the aesthetics and usability attributes. The data for the analysis was collected when participants interacted with the *measured* task.

The aesthetic manipulation had two different sets of pages, one that had all the design principles applied *(high aesthetics)* and the other that violated all of them *(low aesthetics)*. The usability manipulation had two levels, one that had one error message (when entering user and password), 6s delay between screens and several error messages *(low usability)* and another without error message or delays *(high usability)*. The 6s delay occurred between screens from each different set of pages and on the instructions screens; however, during the navigation on the same set of pages like *material* content and *calendar* it did not have any delay. The rating order was set so that the same condition would be evaluated in two different ways. One started evaluating aesthetics first, followed by usability and

then aesthetics again (aesth/usab/aesth) and the other evaluated usability first, then aesthetics and again usability (usab/aesth/usab). The eight different conditions generated by the rating order, aesthetics and usability manipulation are presented in Table 8.1 and the codes used in Table 8.2:

Table 8.1: Experimental conditions.

		Aesthetics			
		High		Low	
		A/U/A	U/A/U	A/U/A	U/A/U
Usability	Low	Group 1 (1AX)	Group 2 (1AY)	Group 5 (2AX)	Group 6 (2AY)
	High	Group 3 (1BX)	Group 4 (1BY)	Group 7 (2BX)	Group 8 (2BY)

Table 8.2: Codes used for the conditions.

Aesthetics	Usability	Rating order
1 = high aesthetics	A = low usability	X = aesth/usab/aesth
2 = low aesthetics	B = high usability	Y = usab/aesth/usab

2.1 Part 1

The software simulating a prototype of a VLE was the same one used in experiment 3. It also used three sets of pages *home, material* and *e-mail,* each one prepared in two different layout designs (Figure 8.1), one that applies all the design principles, called *high aesthetics* and another that violates all of them, called *low aesthetics*. Each aesthetics level was presented in two usability levels; *high usability* presented no delays or error messages and low usability presented 6s delays and several error messages.

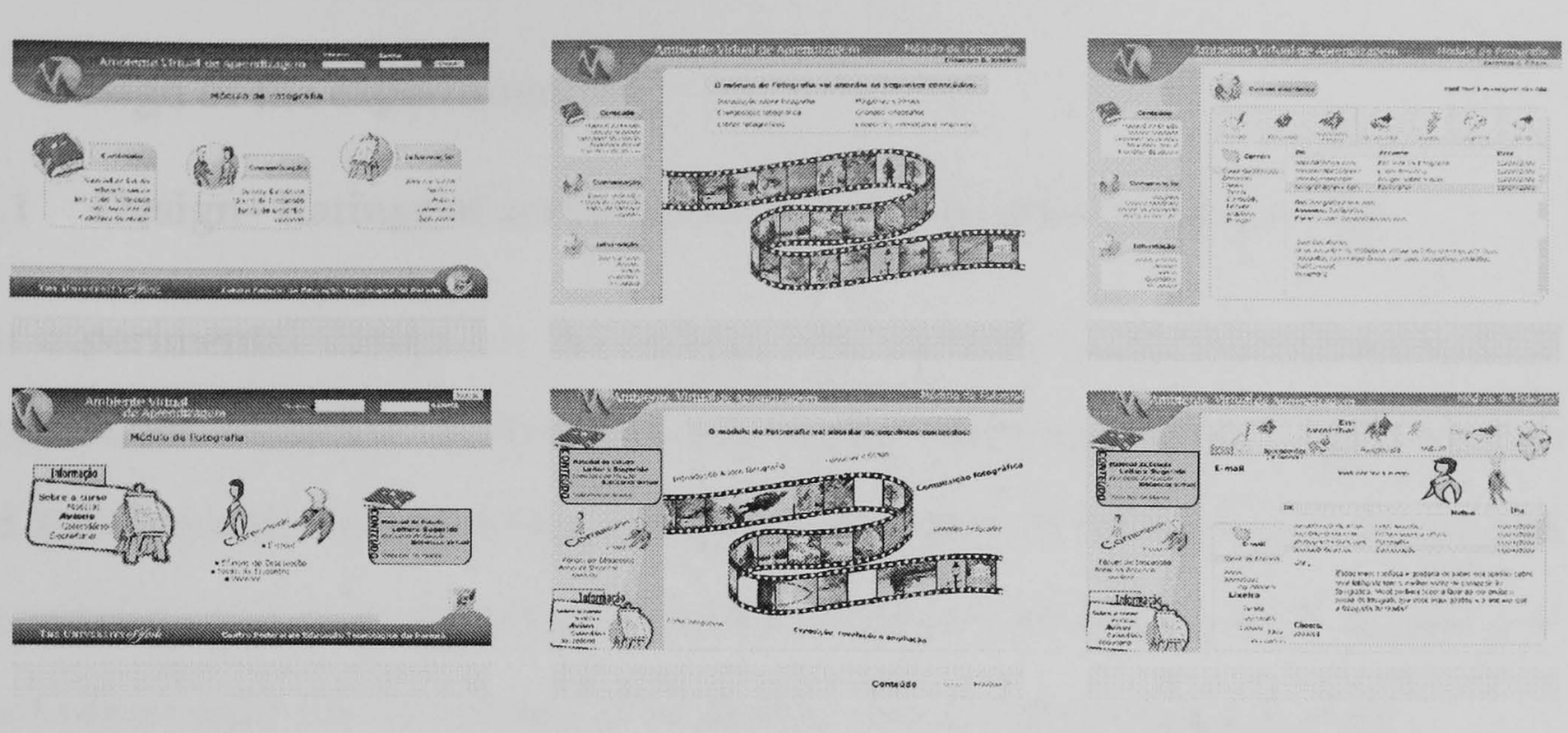


Figure 8.1: Examples of three sets of pages *(home, material* and *e-mail)* each one represented in two distinctive layout designs.

2.2 Part 2

The second part intended to re-evaluate the aesthetics and usability aspects of the VLE prototype used. Like experiment 3, two different *e-mail* screen layouts were shown side by side (Figure 8.2). Each participant was asked to choose the screen layout they perceived to be more attractive (*screen* A or *screen* B) and then the screen layout they believed to be easier to use (Appendix 4). This was independent of the condition they were assigned to complete in Part 1.

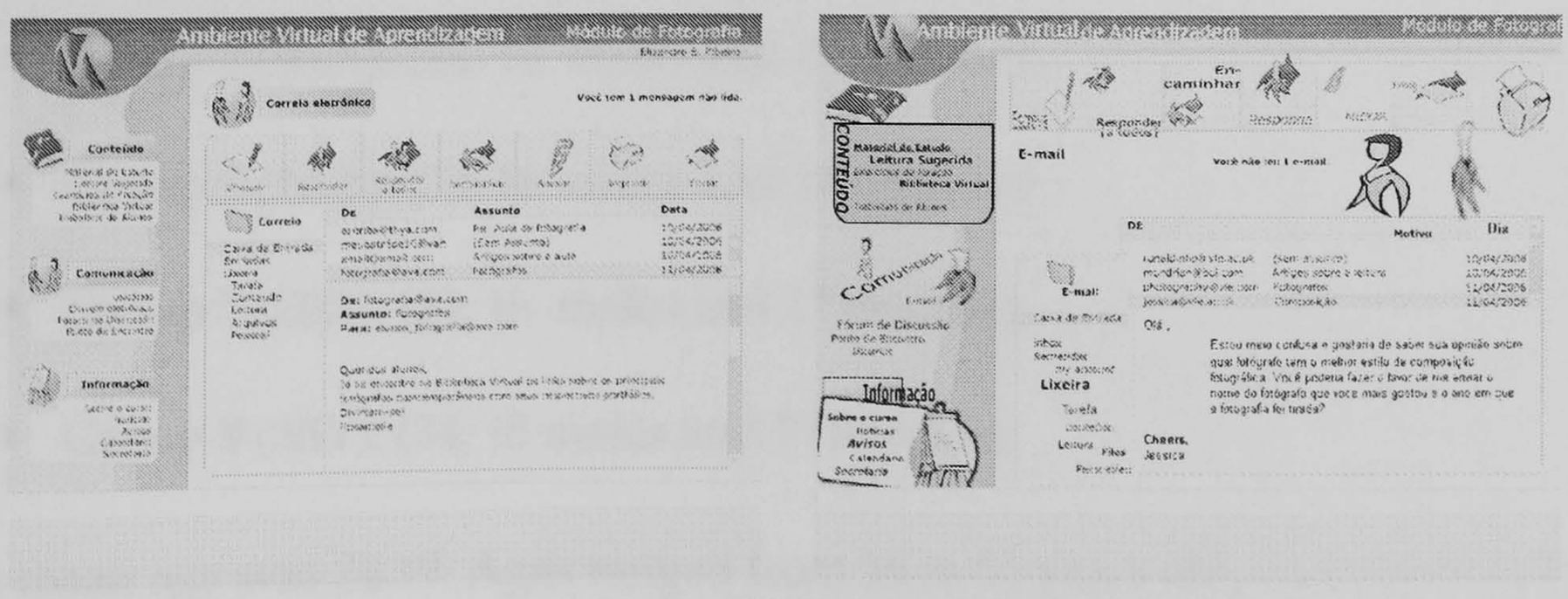


Figure 8.2 – Thumbnails of screen A *(high aesthetics)* and screen B *(low aesthetics).*

3 METHOD

3.1 Design of the experiment

3.1.1 Design– Ratings of aesthetics and usability after using the VLE

The experimental design for the ratings was 2x2x2 between-subject with three independent variables: aesthetics manipulation with two levels (*high aesthetics* and *low aesthetics)* and usability manipulation with two levels (*high usability* and *low usabi*lity) and order of rating with two levels (A-U-A and U-A-U). It used a 5-point Likert scale for the ratings of aesthetics and usability manipulations.

3.2 Participants

The study involved 267 participants enrolled or working at a Higher Education Institution in Brazil (UTFPR). There were 8 groups formed by the factorial combination of aesthetics manipulation *(high* and *low aesthetics),* usability manipulation *(high* and *low usability)* and order of rating (A-U-A and U-A-U).

- Group 1 (1AX): (34; 16 males and 18 females);
- Group 2 (1AY): (34; 16 males and 18 females);
- Group 3 (1BX): (33; 15 males and 18 females);
- Group 4 (1BY): (33; 15 males and 18 females);
- Group 5 (2AX): (34; 16 males and 18 females);
- Group 6 (2AY): (33; 16 males and 17 females);
- Group 7 (2BX): (33; 16 males and 17 females);
- Group 8 (2BY): (34; 15 males and 19 females);

The mean age was 24.19. Ages ranged from 16 to 56 years old. Overall there were 125 males and 142 females.

3.3 Material and apparatus

The physical environment for this experiment was the same used by experiment 3. The room layout for positioning the three computers was very similar to the previous study. Also, the computers' specification and screen size were the same. There could be one or three participants at the same time.

The same *measured* interactive VLE interface was used as in experiment 3 to evaluate the aesthetics and usability attributes (Appendix 4).

The *training* interface, like the *measured* interface, was also developed with two different aesthetic manipulation levels, *high aesthetics* and *low aesthetics* and two levels of usability manipulation, *high usability* and *low usability* (6s delay between different sets of pages and error message on the login, sending email and several others when clicking where there was not a link). All participants experienced both levels of usability manipulation and both levels of aesthetics manipulation in different parts of the *training* VLE interface independent of the *measured* interface.

The use of a *training* interface allowed the participant to have a better idea about the nature of a VLE and it gives the participant something to compare with (Appendix 6). It was presented in a different graphic style (square shape) and colour (different shades of green); however, it had similar tasks and ratings to be completed.

3.4 Procedure

The procedure was the same as for experiment 3 except for the fact that the participants had to evaluate one of the variables twice (e.g. rate aesthetics, then usability and aesthetics again).

Before starting to gather and record the data for the analysis every participant was exposed to the same *training* interface before taking part in the *measured* interface. For the *measured* interface each participant would be assigned to one of the eight groups.

The *training* interface intended to level the participant anxiety and his performance for the *measured* interface. It gave the opportunity for the participants to get familiar with the physical environment (chair, monitor, mouse, lights, etc) as well to the type of tasks to be completed and the nature of the interface under study. The tasks were similar to the *measured* interface, the navigation strategies, and the way to answer the e-mails and the type of evaluation of the environment by clicking on a button of a 5-point Likert scale.

The variables were manipulated in the same way for the *training* and *measured* interfaces. The difference is that in the *training* interface there were two distinct conditions, *high aesthetics* with *high usability* combined with *low aesthetics* with *low usability* whether the measured interface was presented in eight different conditions.

The experiment started by presenting the first set of pages (*home*) showing an introductory page of the module of Photography asked for the login and password to enable the participant to proceed with the task and navigate to the *e-mail* page, where they received an e-mail asking a question which required them to navigate through the *material* pages, where the content, a topic from black&white photography, presented a short explanation followed by seven examples of photography exemplifying different themes and composition. After that, they had to return to *e-mail* to reply to it with their answer. The two tasks were based on receiving and answering e-mails from friends and students. The main reason for this is because the e-mail is a well known and very common

communication tool and the participants knew it quite well, making the tasks very familiar to them.

When the participants had finished the two tasks they were asked to evaluate the VLE prototype condition used using a 5-point Likert scale, varying from 1 *(unattractive)* to 5 *(attractive)* for the aesthetic aspect. They were instructed to evaluate the VLE focusing on their satisfaction when navigating this particular VLE. This process was then repeated for the usability aspect, using a 5-point Likert scale, ranging from 1 *(difficult to use)* to 5 *(easy to use)* and the evaluation would be based upon their judgement of how easy to use the environment was. They could spend as much time as they wanted to evaluate it and only when they clicked on the button (①, ②, ③, ④ or ⑤) to rate the interface would the screen change to the next one.

The VLE prototype navigation presented only one active link at a time to ensure that all the participants would follow the same path and see the same screens during the tasks. On the other hand, whenever the participant clicked an inactive link it would present an error message that could be in the same language displayed by the software (Portuguese) or in English. This allowed the participants to go back and forth on the software during the navigation process as much as they liked before writing the answer. The answer could be changed as many times as they wished and just when the participant actually clicked on the send button would the task finish. The software did not allow the use of the 'copy-paste' feature to prevent the same answer being repeated many times instead of having a unique answer for each participant. The format of the e-mail they had to write was free. In this way, it was possible to observe a variety of communication styles (e.g. formal or informal) and different ways of writing (e.g. just giving the answer or adding personality) using the same tool.

The program ensured participants rated both aspects before finishing the computer experimental parts. They had to rate the three questions (A-U-A or U-A-U) before completing the experiment. It was not possible to return to the previous screen as this would cause problems in recording and interpreting the data acquired.

Table 8.3: Average time to complete each condition.

Group	Rating order	Average time spent (min)	
		Training task	Measured task
Group 1 (1AX)	Aesth/Usab/Aesth	13 min	07 min
Group 2 (1AY)	Usab/Aesth/Usab	15 min	09 min
Group 3 (1BX)	Aesth/Usab/Aesth	15 min	07 min
Group 4 (1BY)	Usab/Aesth/Usab	14 min	07 min
Group 5 (2AX)	Aesth/Usab/Aesth	15 min	09 min
Group 6 (2AY)	Usab/Aesth/Usab	13 min	09 min
Group 7 (2BX)	Aesth/Usab/Aesth	15 min	09 min
Group 8 (2BY)	Usab/Aesth/Usab	20 min	07 min
	Total average	15 min	08 min

Table 8.3 shows the average time the participants spent navigating on the *training* and on the *measured* interface to complete the experiment on each one of the eight conditions. The participants spent almost twice as long on the *training* interface to complete the tasks as on the *measured* interface. I could be concluded that the *training* interface had the desired outcome of getting the participants comfortable with the environment.

4 RESULTS

4.1 Part 1: Aesthetics and Usability ratings

The experimental design for the ratings was 2x2x2 between-subject with three independent variables: aesthetics manipulation with two levels (*high aesthetics* and *low aesthetics*), usability manipulation with two levels (*high usability* and *low usability*) and order of rating with two levels (A-U-A and U-A-U).

The analysis of this experiment will be in two parts. The first part parallels exactly the analysis for experiment 3 except that there is an additional independent variable, order of rating. That is, it just considers the first two ratings (A-U-A and U-A-U, A-U-A and U-A-U). The second part looks at the last two ratings, that is (A-U-A or U-A-U). This latter analysis is simply to see what effect there is of repeating the same rating.

4.1.1 First ratings of aesthetics

The aesthetics ratings were analysed in a 2x2x2 between-subject ANOVA, as explained above. The aesthetics manipulation had a large influence on the way participants rated the aesthetic attributes, repeating similar results found in experiment 3.

The 3-way between-subjects ANOVA revealed that the main effect of the aesthetics manipulation was significant ($F_{(1,259)} = 117.789$, $p < .05$), showing that the aesthetic attributes have a large influence on the way the participants perceive the interface.

The main effect of the usability manipulation was not significant ($F_{(1,259)} = 2.105$ $p = .148$), so the usability attributes do not interfere with the way participants rated aesthetic attributes.

The main effect for the rating order was significant ($F_{(1,259)} = 4.679$, $p < .05$). The means where the aesthetics manipulation was rated first are shown in Figure 8.3.

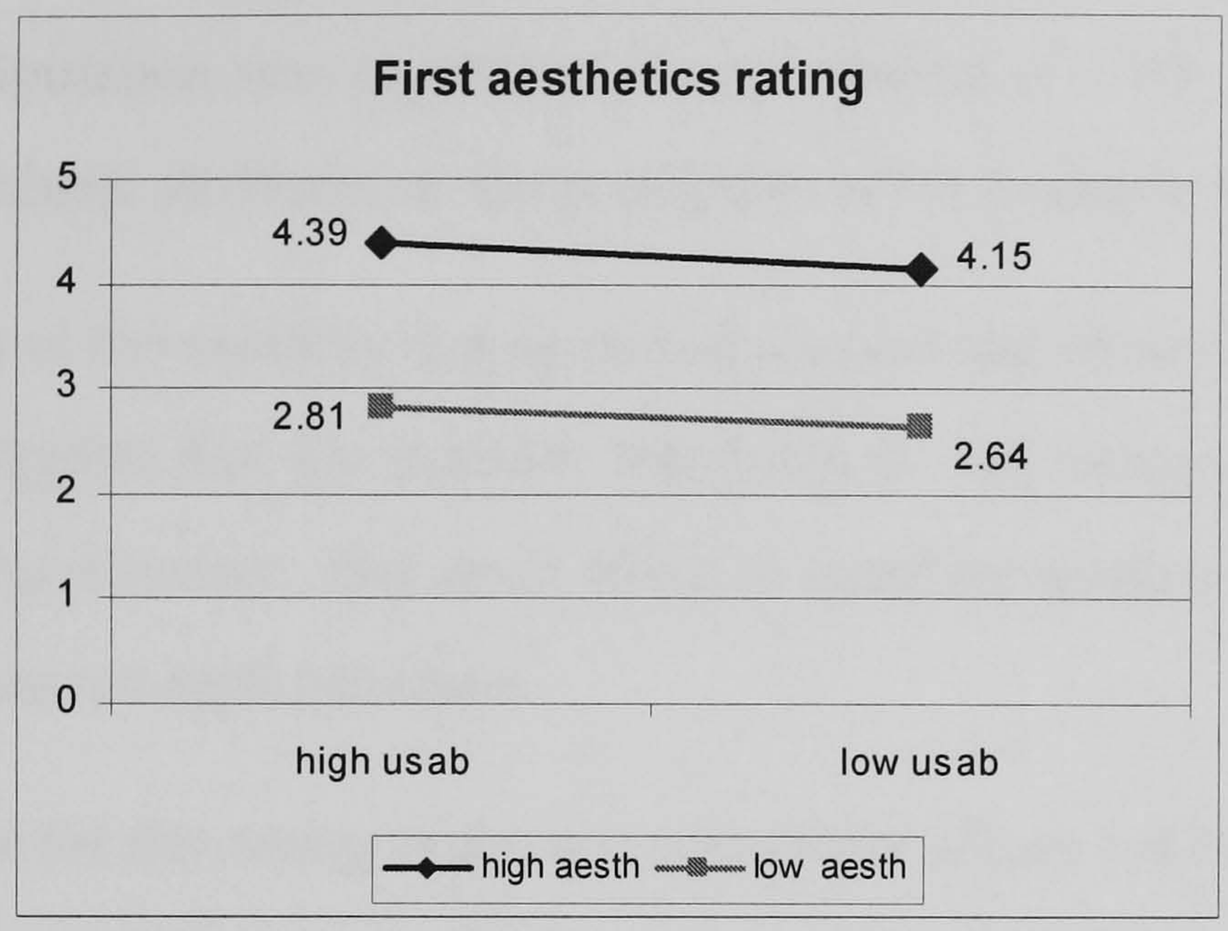


Figure 8.3: Evaluation of the aesthetics ratings first (A-U-A and U-A-U).

The interaction between aesthetics manipulation and rating order was not significant ($F_{(1,259)} = 1.206$, $p = .273$). Also, the interaction between usability manipulation and rating order was not significant ($F_{(1,259)} = .037$, $p = .848$). These suggest that rating order would not affect the participant's perception of aesthetics or usability.

There was no significant interaction between aesthetics and usability manipulation ($F_{(1,259)} = .063$, $p = .802$). Also, there was no significant 3-way interaction between aesthetics manipulation, usability manipulation and rating order ($F_{(1,259)} = .201$, $p = .654$).

4.1.2 First ratings of usability

The usability r atings were analysed in a 2x2x2 between-subject ANOVA, as explained above. It seems that the usability manipulation does not influence the

way the participants rated the usability attributes. The influence found in the previous experiment was small and disappears in this experiment.

The 3-way between-subjects ANOVA revealed that the main effect of the aesthetics manipulation was significant ($F_{(1,259)} = 96.954$, $p < .05$), showing a big influence of aesthetic attributes on the perception of the usability of the interface.

The main effect of the usability manipulation was not significant ($F_{(1,259)} = 1.283$ $p = .258$). This suggests that the usability attributes do not influence participants' perception of the interface. The small effect of usability manipulation found in experiment 3 was not replicated here.

The main effect for the rating order was significant ($F_{(1,259)} = 4.266$ $p < .05$). The means where the usability manipulation was rated first are shown in Figure 8.4.

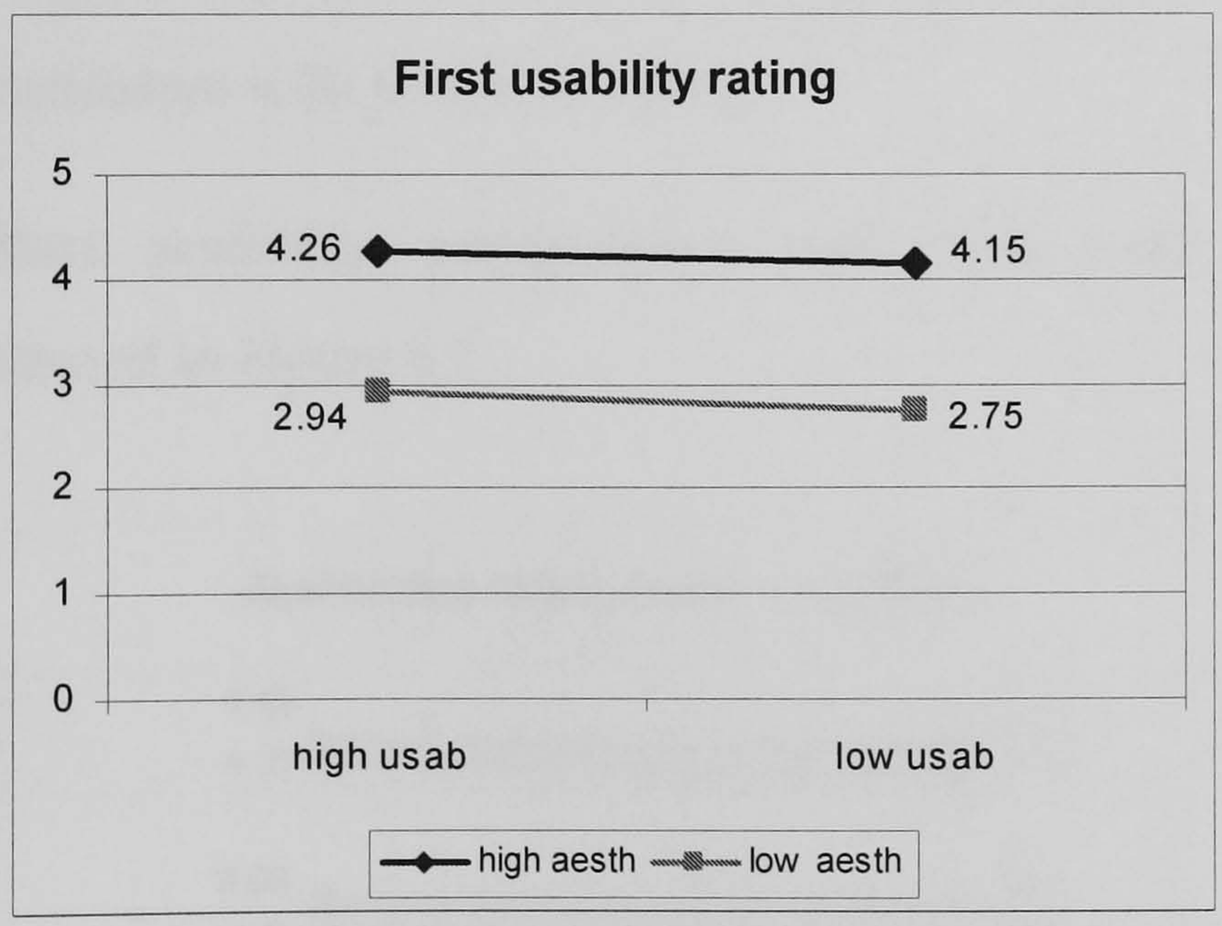


Figure 8.4: Evaluation of the usability ratings first (U-A-U and A-U-A).

The interaction between aesthetics manipulation and rating order was significant ($F_{(1,259)} = 9.223$ $p < .05$). However, the interaction between usability manipulation and rating order was not significant ($F_{(1,259)} = .062$ $p = .804$).

There was no significant interaction between aesthetics and usability manipulation ($F_{(1,259)}$ = .121, p = .728). Also, there was no significant 3-way interaction between aesthetics manipulation, usability manipulation and rating order ($F_{(1,259)}$ = .570, p = .451).

4.1.3 Rating order

The rating order effect was analysed in a 3-way analysis of variance. There were two between-subject factors: *aesthetics manipulation* with two levels and *usability manipulation* with two levels and one repeated measures factor, *order of rating* with two levels.

The repeated measures ANOVA reveals a similar results pattern to participants' ratings for first rating time and second rating time. The fact that the participant had to rate the same variable twice did not change their first answer, showing that they were consistent with their first rating.

The means where aesthetics manipulation was rated twice (aesth_t1 and aesth_t2) is illustrated in Figure 8.5.

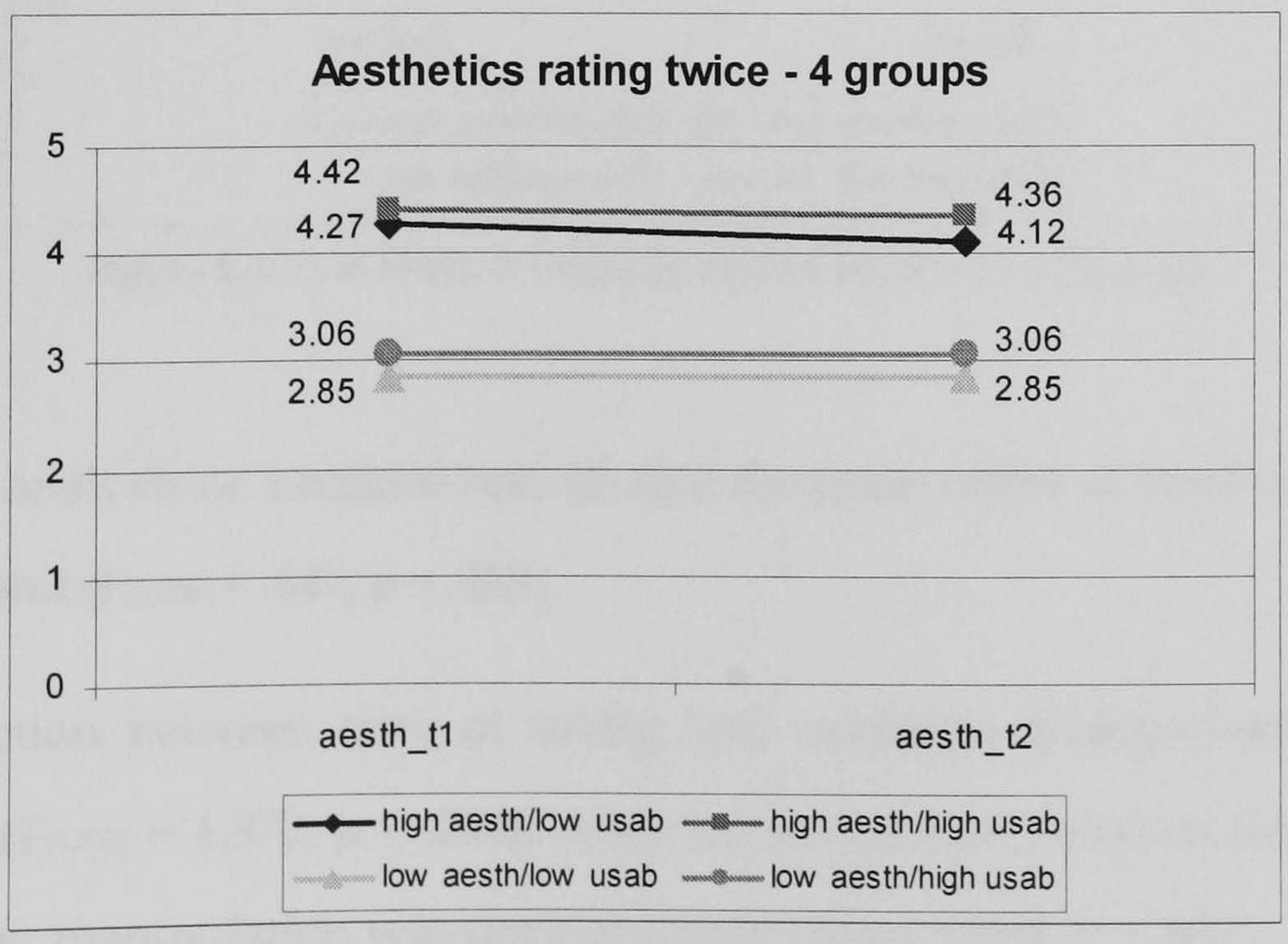


Figure 8.5: Evaluation of aesthetics manipulation twice (A-U-A).

The 3-way analysis of variance reveals that the main effect of time of rating was not significant ($F_{(1,129)} = 2.000$, $p = .160$).

The interaction between time of rating and aesthetics manipulation was not significant ($F_{(1,129)} = 2.000$, $p = .160$). Also, the interaction between time of rating and usability manipulation was not significant ($F_{(1,129)} = .367$, $p = .546$).

The 3-way interaction between time of rating, aesthetics manipulation and usability manipulation was not significant ($F_{(1,129)} = .367$, $p = .546$).

The means where usability manipulation was rated twice (usab_t1 and usab_t2) are illustrated in Figure 8.6.

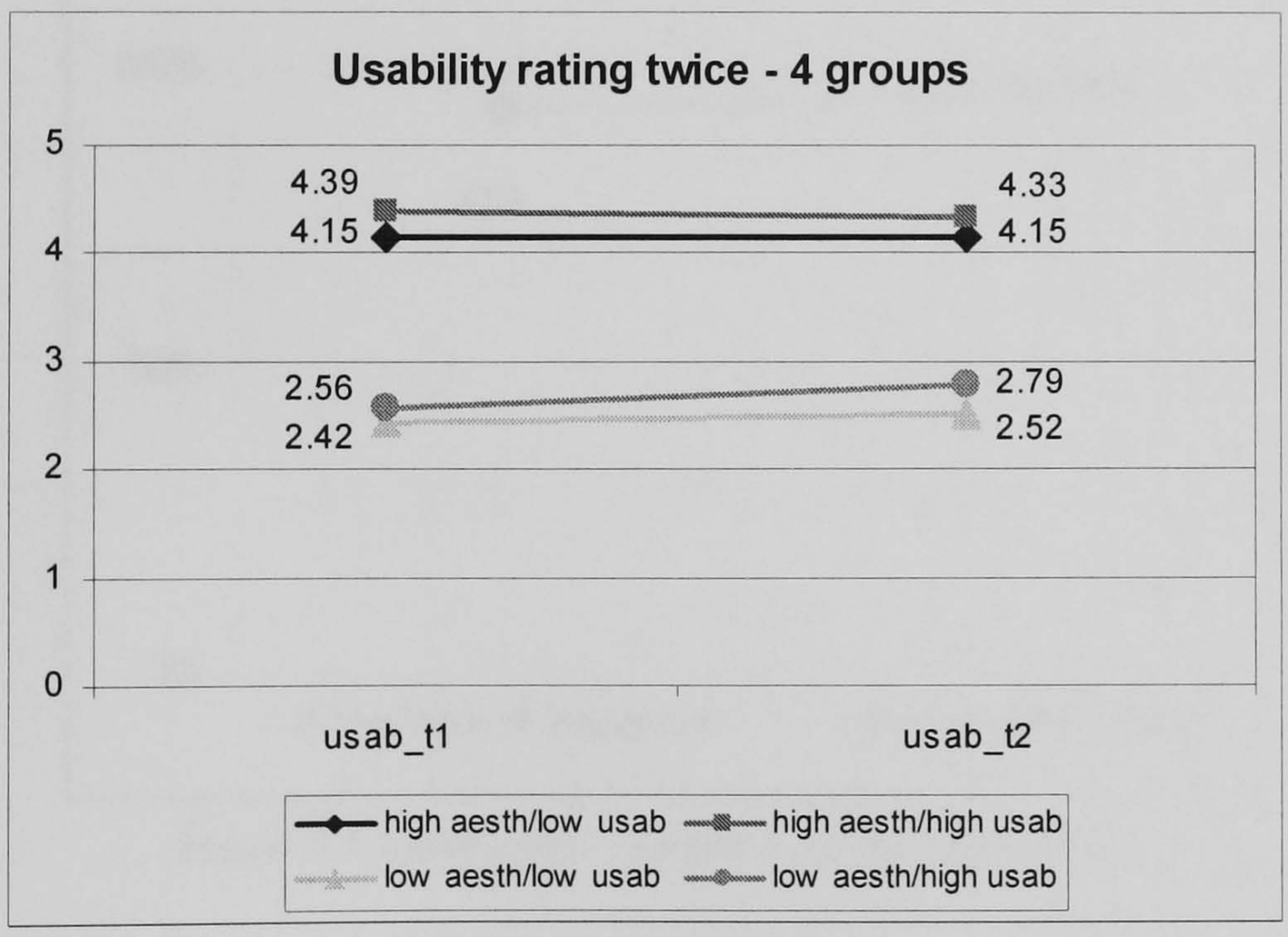


Figure 8.6: Evaluation of usability manipulation twice (U-A-U).

The 3-way analysis of variance reveals that the main effect of time of rating was not significant ($F_{(1,130)} = .647$, $p = .423$).

The interaction between time of rating and aesthetics manipulation was not significant ($F_{(1,300)} = 1.372$, $p = .244$). Also, the interaction between time of rating and usability manipulation was not significant ($F_{(1,130)} = .064$, $p = .800$).

The 3-way interaction between time of rating, aesthetics manipulation and usability manipulation was not significant ($F_{(1,130)} = .385$, $p = .536$).

4.2 Part 2: Two alternative forced choice

This part intended to test the participants' preference when comparing between two different screen layouts, *high aesthetics* and *low aesthetics,* for the *e-mail* set of pages. All participants evaluated the same screen layouts on their aesthetics and usability attributes independent of the assigned condition. The results are shown in Figures 8.7.

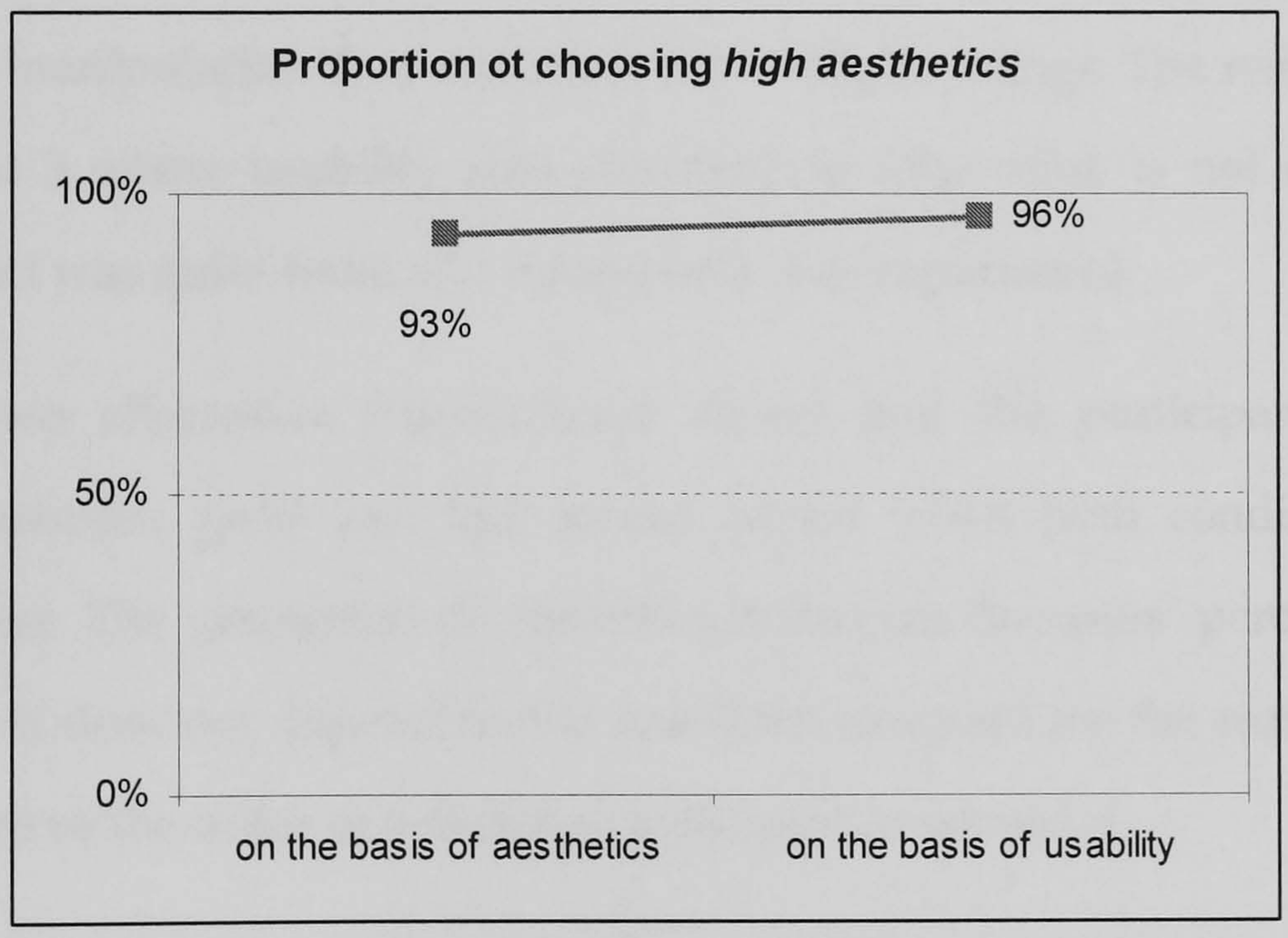


Figure 8.7: Participants' evaluation of the best layout.

5 DISCUSSION

The results of this experiment showed that the manipulation of aesthetics had an effect on rating aesthetics and usability attributes and that results of a between-subject ANOVA were statistically significant and similar for eight different

conditions. The usability manipulation had no effect on any of the ratings. The rating order had an effect on both aesthetics and usability manipulations. However, there was no significant 3-way interaction between aesthetics manipulation, usability manipulation and rating order.

The order in which the participants were asked to rate the aesthetics and the usability manipulation was not important. The fact that the previous experiment always rated the aesthetics manipulation before rating the usability manipulation did not change the results found in previous experiments. This suggests that the participants were consistent in their rating.

The usability manipulation does not affect the aesthetic ratings. The result found in experiment 3 where usability was perceived as important, is not sustained here. The effect was quite small and disapears in this experiment.

Again, the two alternative forced-choice shows that the participants could distinguish between good and bad screen layout when both conditions are shown together. The perception of aesthetics influences the users' perception of usability and it does not depend on the condition assigned for the main part of the experiment or the order in which the participants evaluatd it.

The use of the *training* interface helped to make the participants more comfortable with the VLE environment so that they spent less time completing the tasks using the measure interface.

The key finding of this experiment are that aesthetics attributes have a large effect on the way particpants perceived the VLE interface.

CHAPTER 9

Conclusion and future work

1 INTRODUCTION

This chapter concludes the thesis by providing a brief summary of the work undertaken. It discusses the contributions of the research and addresses some general limitations of interface design. The chapter ends by proposing directions for future work in the area of virtual learning interface design.

The use of VLEs to deliver distance education is a well established practice. However, engaging students in this kind of environment is proving to be a very challenging task with a large scope for research. Another area with a similar broad scope for research is the effect that the design of a computer interface has on the user.

There were two main questions that shaped this research. First, which design fundamentals were relevant to developing the screen layouts for the interface? Second, how do aesthetic attributes influence the usability of an interactive interface?

The usability of an interactive interface can be evaluated using the objective and the perceived usability approaches. The objective usability approach is concerned with time and it measures how long the user spends on an interactive system to complete a particular task and learn how to do it. The perceived usability adopts a more subjective measure and it is concerned with the user's perception of how

easy it is to use an interactive system to complete a particular task. This research used the perceived usability approach and the analysis was made based on participants answers on how easy it was to use the VLE prototype.

1.1 Research summary

The research was conducted in three parts. The first part was a review of the literature on the use of Virtual Learning Environments (VLEs) and the aesthetic attributes. In the second part, an observational study was conducted to provide evidence on how participants communicate in a VLE. Finally, the third part involved four empirical studies to gather evidence to support the hypothesis that aesthetic attributes affect the way users perceive the system's usability. A summary of the research and key findings found in each part is provided in the following sections.

1.1.1 A review of VLEs and aesthetics

The literature review was divided into two parts. The first part aimed to investigate how virtual learning environments (VLEs) are being used to deliver online education and the effect that this type of interface has on students. The second part focused on the aesthetic attributes of the interface and how they can affect the students' perception of the environment.

The use of computers offers significant advantages over traditional distance education and with the increasing dissemination of the technology virtual learning environments (VLEs) have become an important area of research. There are many potential benefits of using a VLE for education and training, such as: flexibility (e.g. mature students that work full or part time or students that live far away from educational institutions), economy and quality. The framework proposed by Mason (2002) considers a wide rage of online courses and divides

them into three main models: content +- support, wrap around and integrated model. This research considered the content + support model because the interface for this model is more predictable than the others, making it ideal for this research.

The motivation to study aesthetic attributes applied to VLEs came from the fact that this type of environment is quite new and its acceptance by the user could be more related to its appearance than to its features. There are several studies suggesting that interface aesthetics plays a vital role in learnability and the transfer of information. In a similar way, there are other studies reporting a strong correlation between aesthetics and usability.

The Gestalt theory was found to be relevant to designing better screen layout for VLEs because they are developed with the purpose of helping individuals to learn more efficiently and, specially, using a more pleasing environment. Also, the Emotional Design theory provides evidence about how the individual can be affected by the appearance of the interface.

1.1.2 The use of a VLE

The observational study of the use of a VLE was intended to understand how participants of an online course use the environment features to communicate with each other. It reveals that the students were confident with the technology and the communication tools. However, the number of questionnaire responses was not encouraging and the research paradigm was changed for practical reasons.

1.1.3 Empirical studies

The first experiment aimed to test the value of using design principles to develop screen layouts that are aesthetically pleasing. The experiment presented twelve

screen layouts to the participants (four variations of the same layout for three different sets of pages), who have to rate them in terms of attractiveness and ease of use. The design was within-subject and there were 279 participants. The results provided evidence supporting the value of all five design principles as well as the use of dynamic symmetry to generate the grid. The manipulation of aesthetics had a strong effect on the ratings of aesthetic and usability attributes, so the screen layouts that applied the design principles are perceived as being more attractive and easier to use than the ones that violate the design principles. Another important finding was that the perception of good layout design was not correlated with age, gender, schooling or background. This supports previous findings which showed that perception of aesthetics is not related with culture.

The second experiment used the screen layouts that applied all the principles and those which violated all the principles to develop an interactive prototype that allowed the participants to navigate through the environment before evaluating the aesthetic and usability attributes of the interface. It used a between-subject design with 88 participants distributed in four different conditions. The results suggested that the aesthetic attributes of the interface have a large influence on the perception of how easy it is to use. The effect of this aesthetic manipulation on usability was strong. This effect could have been due to the limited opportunities that the participants had to interact with it.

The third experiment was to investigate if the results would be the same when the aesthetic and usability attributes received a stronger manipulation. As before, the design was between-subject with 98 participants. This time a *training* interface was introduced for the participants to use in order to reduce their anxiety towards the experiment before being assigned to one of the four conditions. This time the results showed an even greater effect of aesthetics on

the usability. Once more, the results were consistent with previous findings and suggest that a stronger manipulation of aesthetic attributes will affect even more the perception of the system usability.

The fourth and last experiment was designed to check if the rating order could change the way participants would rate aesthetics and usability. The effect of aesthetics found in the previous experiment could be due to the fact they evaluated it prior to usability. It had a between-subject design and the 267 participants were distributed into eight conditions instead of four in experiment 3. This allowed each one of the four conditions to be rated in two different orders, one rating aesthetics first and another rating usability first. The participants used the same *training* interface and also the same *measured* interface. The order of rating was not important and the results showed that aesthetic attributes have an even larger effect on the ratings of usability than the one from experiment 3.

In summary, the experiments gave strong evidence that the aesthetics attributes of the interface layout play a significant role in the perception of the usability of the whole system.

1.2 Future work

This research was limited to VLE interface design. However, the fundamentals of graphic screen layout can be applied to many different types of interface giving several directions in which this research could be extended.

The use of the design principles and the dynamic symmetry theory can be very helpful to develop screen layouts for other types of interfaces, such as the web.

There is a great deal of research potential for screen design applied to VLEs. The next step could be investigating if this approach might lead to a greater

motivation of the students. It could make use of existing courses where half of the students could use the current VLE and the other half would use a VLE which follows this research approach. The time spent logged in, the students' attitudes towards the VLE and the final grades of each student could supply relevant information. However taking an experimental approach could raise ethical problems it would be unfair to the students who were selected to use the interface with a low aesthetics approach.

1.3 Final remarks

This research was concerned with investigating the importance of aesthetics in the design of virtual learning environment interfaces and this work provides the results of extensive studies on how aesthetics affects the users' perception of the usability of a virtual learning environment. They were developed to be as realistic as possible for an experimental situation and the results are consistent throughout the four experiments and corroborate the findings reported from the literature review.

The first study was based on the observation of students' attitudes towards the communication tools during one online course. Although the VLE used to deliver that specific module provided state-of-the-art features it showed that it is a very difficult task to motivate students to communicate and interact with each other outside lectures. The constraints of this approach led this research to a more experimental one. The main advantage of the experimental approach of this research was that the investigators had control over the VLE interfaces used. However, the prototypes used were developed specially for the experiments and the participants would interact with them in a controlled way performing fictitious tasks.

The research contributed to an increased understanding of the relation between graphic and interface design and its added value on interface usability. This is an important issue as the fundamentals of graphic design have been demonstrated to be very important to develop screen layouts for other type of media.

However, conducting research on VLE interface design has its own problems and issues, such as the subjective matter of aesthetics, the nature and diversity of interface features and the expensive process of developing different interface prototypes.

This research pursued the hypothesis that aesthetic attributes affect the perception of the usability of an interactive interface. Over the period of almost two years it tested four variations of the same environment with a total number of 731 participants of different ages, genders and backgrounds.

Perhaps the most important contribution of this research has therefore been that by showing the importance that aesthetics have on the system's perceived usability it helped to open a research opportunity within the study of VLE interface design.

Chapter 10

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Appendix 1

Observational study

This appendix presents the letter of information and consent form used in the observational study. This material was placed online together with the course material. The students would complete them online.

Evaluating the use of collaborative tools in Virtual Learning Environments

Letter of information

The Project Management Module is participating in a research project called 'Evaluating the use of collaborative tools in Virtual Learning Environments'. It intends to investigate how the participants of online courses use collaborative tools to communicate with each other in order to support online learning using Virtual Learning Environments.

As part of this research, we will ask you to complete two short questionnaires, one at the beginning and the other at the end of the module. In addition, the students are asked to fill in two diaries during the development of the module. Both of them intend to collect information about the use of collaboration tools in the VLE/LearnLinc (this information is automatically recorded by LearnLinc). None of them should involve any risk or inconvenience to you.

I understand that the participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. Any information that I have provided as part of the study will be confidential and my identity removed unless I agree otherwise before using it to any scientific publication.

Any questions about the research may be addressed to:

Rosamelia Parizotto Ribeiro
Department of Psychology
University of York – Heslington
YO10 5DD – York
Telephone: +44 (01904) 433178
e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-1.1: Letter of information.

THE UNIVERSITY of York

Consent from Students (use the department of Psychology printed paper)

Investigator's name: Rosamelia Parizotto Ribeiro

Title of study: Evaluating the use of collaborative tools in Virtual Learning Environment

Brief description of study: This research project intends to investigate how the participants of online courses use collaborative tools to communicate with each other in order to support online learning using Virtual Learning Environments.

Declaration of consent

I have been informed about the aims and procedures involved in the experiment in which I am about to participate. I understand that the participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. Any information that I have provided as part of the study will be confidential and my identity removed unless I agree otherwise.

I agree to participate in this Research

Name _____

Signature _____

Email address _____

Date _____

Figure A-1.2: Consent form.

Student Dairy *(based on SOLE Dairy)*

Every time you use LearLinc to do something related with Project Management Module, please record the following information.

We are interested on looking how you are using the collaborative tools in this Virtual Learning Environment (LearLinc). We want to know how useful the tools are for you and how successful is the outcome of the task.

What activity were you involved in? (e.g. discussion with friends, asking questions of the tutor and/or other student(s), reviewing the lecture (seminars/workshops)

What kind of tools did you use?

O Online course material O Email O Chat O Bulletin board O Video conferencing

What time of day you were using the tool?

O Morning O Afternoon O Night O Late in the night

For how long did you use the tools?

O 15 to 30 minutes O 31 to 59 minutes O 1 to 2 hours O more than 2 hours

When you were using the tools, how successful was the outcome?

O Successful O Partially successful O Unsuccessful

Do you have any comments about using the LearnLinc collaborative tools?

Figure A-1.3: Student dairy to be completed during the course.

Evaluating the use of collaborative tools in VLE

(based on A. Monk and SOLE questionnaires)

This questionnaire intends to look at how you communicate with other students during the Project Management module. The main purpose of this research is to investigate how students use the collaborative tools available in the VLE – LearnLinc.

1 About you

What is your age in years?	O under 20	O 20 – 29	O 30 – 39	O 40 or over
In which country did you attend secondary school?	O England	O Spain	O France	O Germany
What is your first language?	O English	O Spanish	O French	O German

If English is not your native language, how confident are you with English?

Reading	Not at all confident	1 O	2 O	3 O	4 O	5 O	Very confident
Writing	Not at all confident	1 O	2 O	3 O	4 O	5 O	Very confident
Listening	Not at all confident	1 O	2 O	3 O	4 O	5 O	Very confident
Talking	Not at all confident	1 O	2 O	3 O	4 O	5 O	Very confident
General understanding	Not at all confident	1 O	2 O	3 O	4 O	5 O	Very confident

Have you ever used a Virtual Learning Environment before now (e.g. WebCT, Blackboard, etc)?

O Yes O No

If yes, how was the experience?

O Very bad O Bad O Neither good or bad O Good O Very good

Do you have any concerns about using LearnLinc (e.g. fear to use it, unsure about how to proceed, etc)?

O Yes O No

If yes, please state:

Are there any aspects of using LearnLinc that you are looking forward to?

O Yes O No

If yes, please state:

Are there any aspects of using LearnLinc that you are not looking forward to?

O Yes O No

If yes, please state:

2 Reasons for participating in the module

Why are you enrolled in an online module? (Choose as many as you like)

- ☐ It is not being delivered face-to-face.
- ☐ It is not available at the Institution where I am currently studying.
- ☐ I live far away from Educational Institutions.
- ☐ I don't have time to attend face-to-face modules.
- ☐ I want to try new technologies.
- ☐ I work full/part time.
- ☐ Others. Please state:

3 Your learning experience

I like to use the Internet.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	
I enjoy participating in online discussions.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	
I am not very confident about using the Internet.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	
I think online discussions are boring.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	
I prefer to have face-to-face classes.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	
I like the subject studied in this module.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	
I am very motivated to take online classes.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	
I am not very confident with the subject studied in this module.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	
I really enjoy working in groups.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	Not applicable
I find email a very useful tool to communicate with others.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	O
I am not very confident about participating in a chat room.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	O
I find the questions on the discussion board very useful.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	O
I prefer to work by myself.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	O
I don't like to use email.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	O
I really enjoy participating in a chat room.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	O
I find the discussion board boring.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree	O

Figure A-1.4: Questionnaire at the beginning of the course.

End of module questionnaire

This questionnaire focuses on your experience during the Project Management module.

I really enjoyed participating in this module.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
Using this learning environment improved my collaboration with other students.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I felt very involved with what was going on the classes.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
Interacting with other students was not very helpful.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I often found that I wasn't really paying attention to what the tutor said.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I often found that I wasn't really paying attention to what the other students said	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
The learning environment didn't help collaboration with other students.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I found the interaction with other students very helpful.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
This module was not fun to participate in.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I found the discussions during the classes very interesting.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I found it easy to concentrate on what the tutor was saying.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I found it easy to concentrate on what the other students were saying.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I found the classes boring.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree
I did not feel very involved in what was going on during the classes.	Strongly disagree	1 O	2 O	3 O	4 O	5 O	Strongly agree

Clear form Submit form

Thank you for taking the time to complete this questionnaire.

If you have further comments or questions please email R.Ribeiro@psych.york.ac.uk or write to:

Rosamelia P. Ribeiro, Department of Psychology, University of York, York YO10 5DD.

Figure A-1.5: Questionnaire at the end of the course.

Appendix 2

Material for experiment 1

This appendix presents the material used in experiment 1. Appendix 2A presents the letters of information and consent form which were used in English and Portuguese. Appendix 2B shows the five design principles screen layouts. In a similar way, Appendix 2C presents twelve screen layouts, four for each one of the three sets of pages. Appendix 2D shows the two alternative forced-choice layouts. Appendix 2E presents the questionnaires for the hedonic attributes and illustrates the results with a screeplot. Finally, Appendix 2F shows the participants during the experiment.

1 APPENDIX 2A

1.1 Letters of information and consent forms

Aesthetics and Perceived Usability of a Virtual Learning Environments

Letter of information for the Students

CEFET-PR is participating in a research project called 'Aesthetics and Usability of Virtual Learning Environments'. It intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

As part of this research, we will ask you to complete a task using the proposed Virtual Learning Environment and answer some questions about them using a rating scale. The questions intend to collect information about your perception of aesthetics and usability. This should not involve any risk or inconvenience to you.

All participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. All the data collected will be stored and used only for the purpose of the research. The data will also be anonymous and the only people who will have access to it will be the researcher and the Research Committee Members.

Any questions about the research may be addressed to:

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Figure A-2A.1: Letter of information for the students (in English).

Aesthetics and Perceived Usability of a Virtual Learning Environments

Letter of information for the Institution

CEFET-PR is participating in a research project called 'Aesthetics and Usability of Virtual Learning Environments'. It intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

As part of this research, we will ask you to complete a task using the proposed Virtual Learning Environment and answer some questions about them using a rating scale. The questions intend to collect information about your perception of aesthetics and usability. This should not involve any risk or inconvenience to you.

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e-mail: R.Ribeiro@psych.york.ac.uk	e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-2A.2: Letter of information for the institution (in English).

Estética e Usabilidade Percebida de Ambientes Virtuais de Aprendizagem

Carta de informação para os participantes

O CEFET-PR está participando de uma pesquisa sobre 'Estética e Usabilidade de Ambientes Virtuais de Aprendizagem'. A pesquisa pretende investigar a relação entre a estética e a usabilidade percebida pelo usuário de interfaces computacionais usadas como Ambientes Virtuais de Aprendizagem. Esta segunda parte irá investigar a correlação entre a usabilidade e a estética após a interação com a interface proposta desenvolvida com base no uso ou não-uso dos princípios de design.

Como parte desta pesquisa, será pedido aos participantes realizar uma tarefa usando o Ambiente Virtual de Aprendizagem proposto e responder algumas perguntas sobre a interface usando uma escala de avaliação. As perguntas pretendem coletar informações sobre a percepção do participante sobre a estética e a usabilidade da interface. Isto não deverá envolver nenhum risco ou inconveniente ao partipante.

Toda participação é voluntária e reserva ao participante o direito se retirar em qualquer etapa do experimento. Todos os dados coletados serão cuidadosamente guardados e usados somente para propósitos desta pesquisa. Os dados também serão anônimos e as únicas pessoas com acesso a eles serão a pesquisadora e os membros do seu Comitê de Pesquisa.

Qualquer pergunta ou dúvida sobre a pesquisa pode ser feita diretamente a pesquisadora ou encaminhada para:

Rosamelia Parizotto Ribeiro

Department of Psychology
University of York – Heslington
YO10 5DD – York
Telephone: +44 (1904) 432.869
e-mail: R.Ribeiro@psych.york.ac.uk

LaMid – Laboratório de Mídias do CEFET-PR
Av. 7 de Setembro, 3165
80.230-901 - Curitiba
Telefone: 41 (XX) 310-4824
e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-2A.3: Letter of information for the students (in Portuguese).

THE UNIVERSITY of York

Consent from Participants

Investigator's name: Rosamelia Parizotto Ribeiro

Title of study: 'Aesthetics and Perceived Usability of a Virtual Learning Environment'.

Brief description of study: This research project intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This first part of the research will investigate the importance that design principles have on perceived aesthetics of a computer interface.

Declaration of consent

I have read the accompanying letter and I have been informed about the aims and procedures involved in the experiment in which I am about to participate. I understand that the participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. Any information that I have provided as part of the study will be confidential and my identity removed unless I agree otherwise.

I agree to participate in this Research.

Printed name: _____

Signature: _____

e-mail address: _____

Date: _____

Figure A-2A.4: Consent from participants (in English).

THE UNIVERSITY of York

Consent from the Head of the Educational Institution

Investigator's name: Rosamelia Parizotto Ribeiro

Title of study: 'Aesthetics and Perceived Usability of a Virtual Learning Environment'.

Brief description of study: This research project intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This first part of the research will investigate the importance that design principles have on perceived aesthetics of a computer interface.

Declaration of consent

I have read the accompanying letter and I have been informed about the aims and procedures involved in the research project described above. I reserve the right to withdraw any participant at any stage in the proceedings. I understand that the information gained will be anonymous and that the participants' name will not be in any materials used in the research, unless the participants agree otherwise.

I agree that the students and staff of this Educational Institution participate in this Research.

Printed name: _____

Role: _____

Signature: _____

e-mail address: _____

Date: _____

Figure A-2A.5: Consent from the Head of the Educational Institution (in English).

THE UNIVERSITY of York

Consentimento dos participantes

Nome do Investigador: Rosamelia Parizotto Ribeiro

Título do estudo: 'Estética e Usabilidade Percebida de Ambientes Virtuais de Aprendizagem'.

Breve descrição do estudo: Este projeto de pesquisa pretende investigar a relação entre a estética e a usabilidade percebida pelo usuário da interface de um Ambiente Virtual de Aprendizagem. Esta primeira parte da pesquisa irá investigar a importância dos princípios de design na estética percebida em uma interface computacional.

Declaração de consentimento

Eu li a carta anexa e fui informado(a) sobre os objetivos e procedimentos envolvidos no experimento em que eu vou participar. Eu compreendo que a participação é voluntária e eu me reservo o direito de desistir em qualquer fase dos procedimentos. Qualquer informação que eu tenha fornecido como parte do estudo será confidencial e minha identidade removida a menos que eu concorde em contrário.

Eu concordo em participar neste experimento.

Nome: _____

Assinatura: _____

e-mail: _____

Data: _____

Figure A-2A.6: Consent from the students (in Portuguese).

2 APPENDIX 2B

2.1 Design principles

Each one of the five design principles, unity, proportion, homogeneity, balance and rhythm, was shown on a single page using two figures, one that followed all five principles *(screen A)* and the other that violated them all *(screen B)*. Participants were instructed to choose the screen they would prefer *(A or B)* based on their own impression of the best layout.

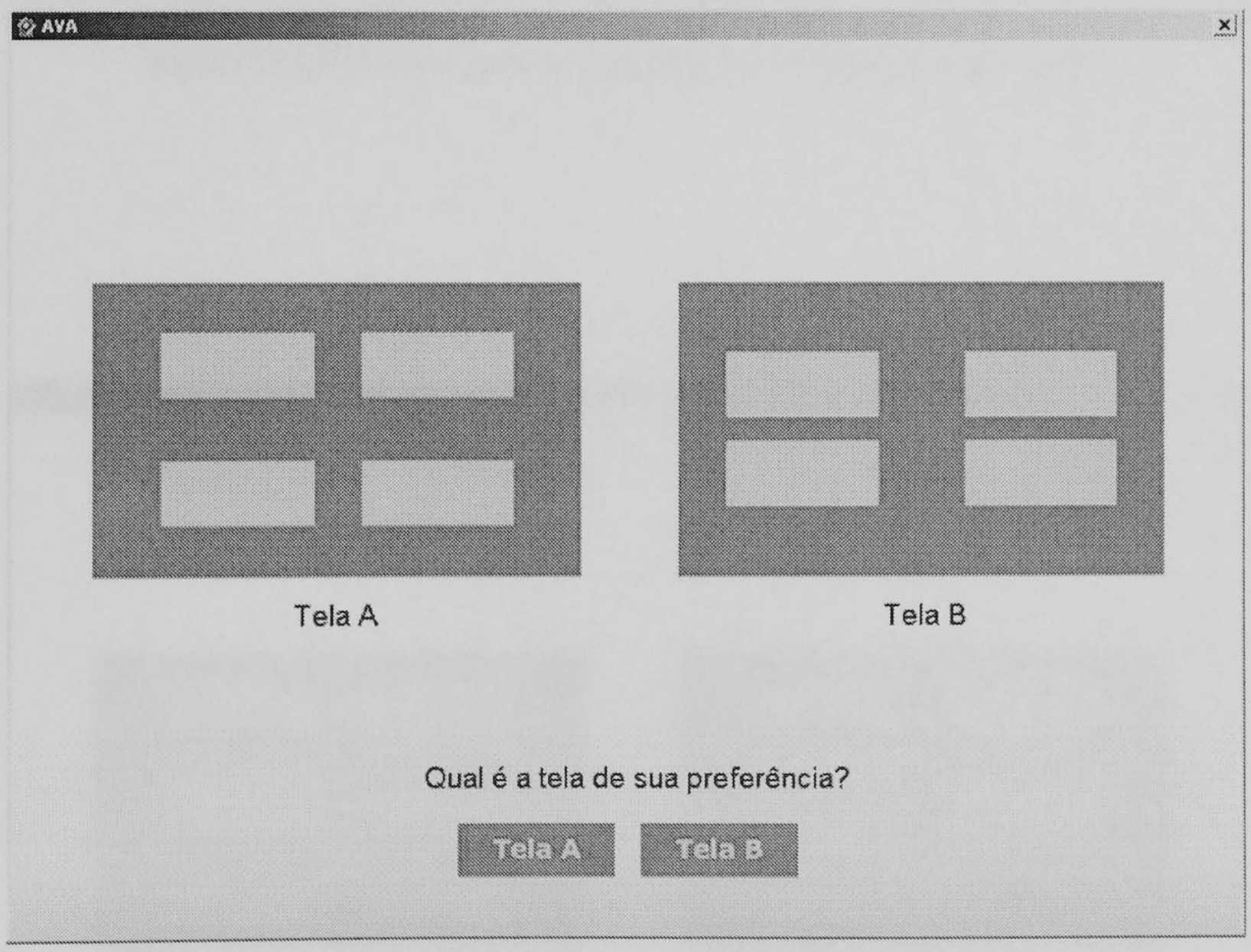


Figure A-2B.1: The screen presenting the design principle *proportion*.

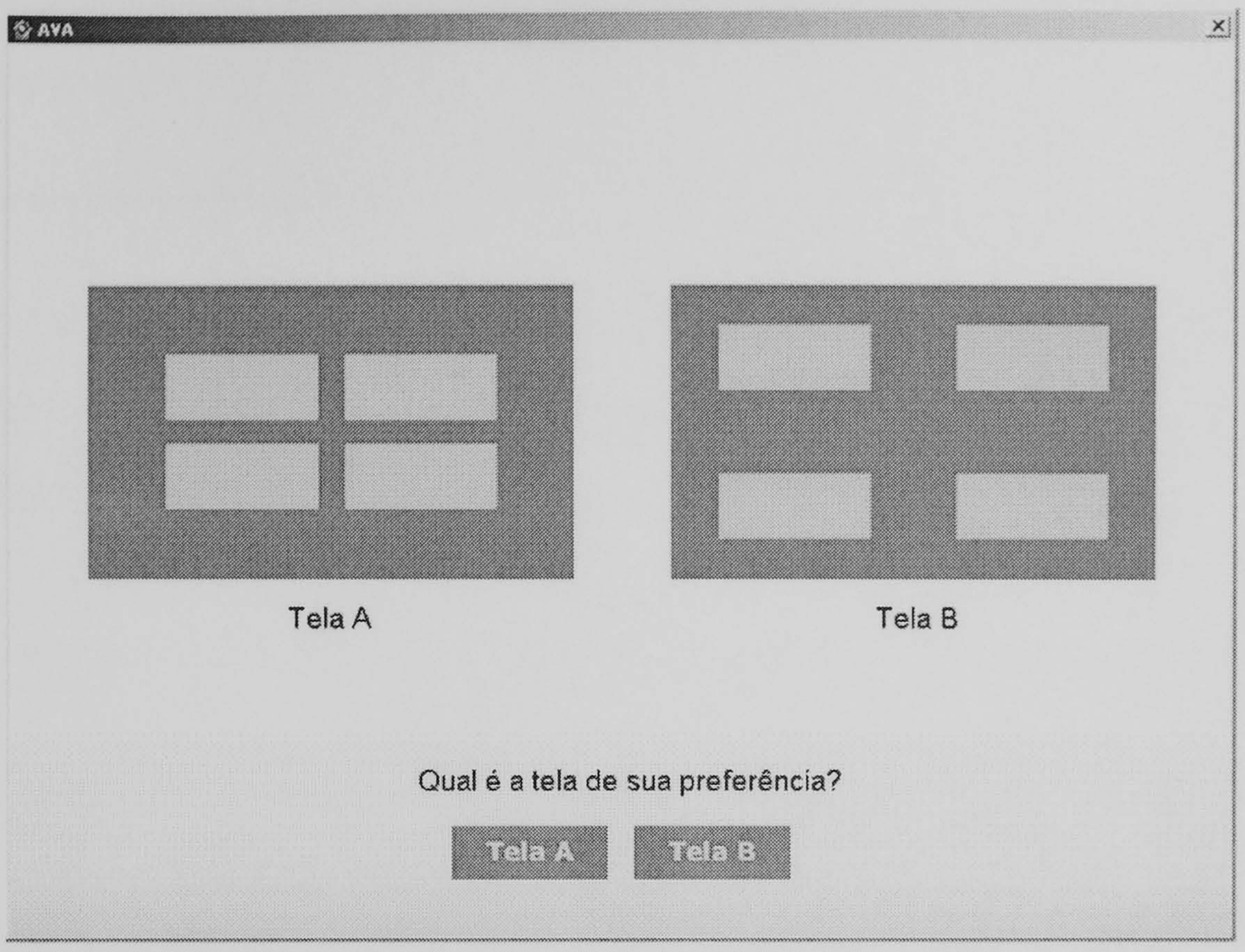


Figure A-2B.2: The screen presenting the design principle unity.

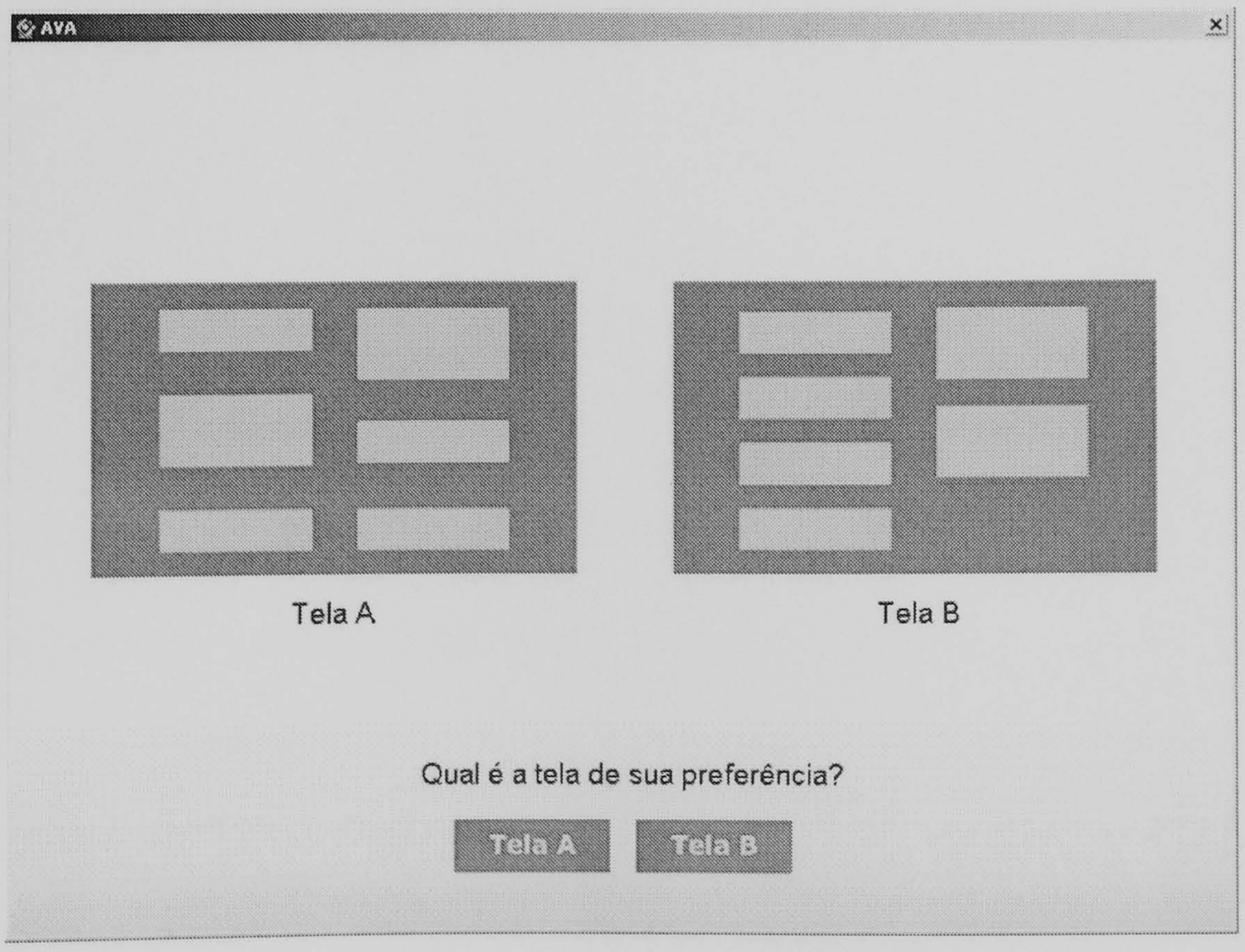


Figure A-2B.3: The screen presenting the design principle *balance*.

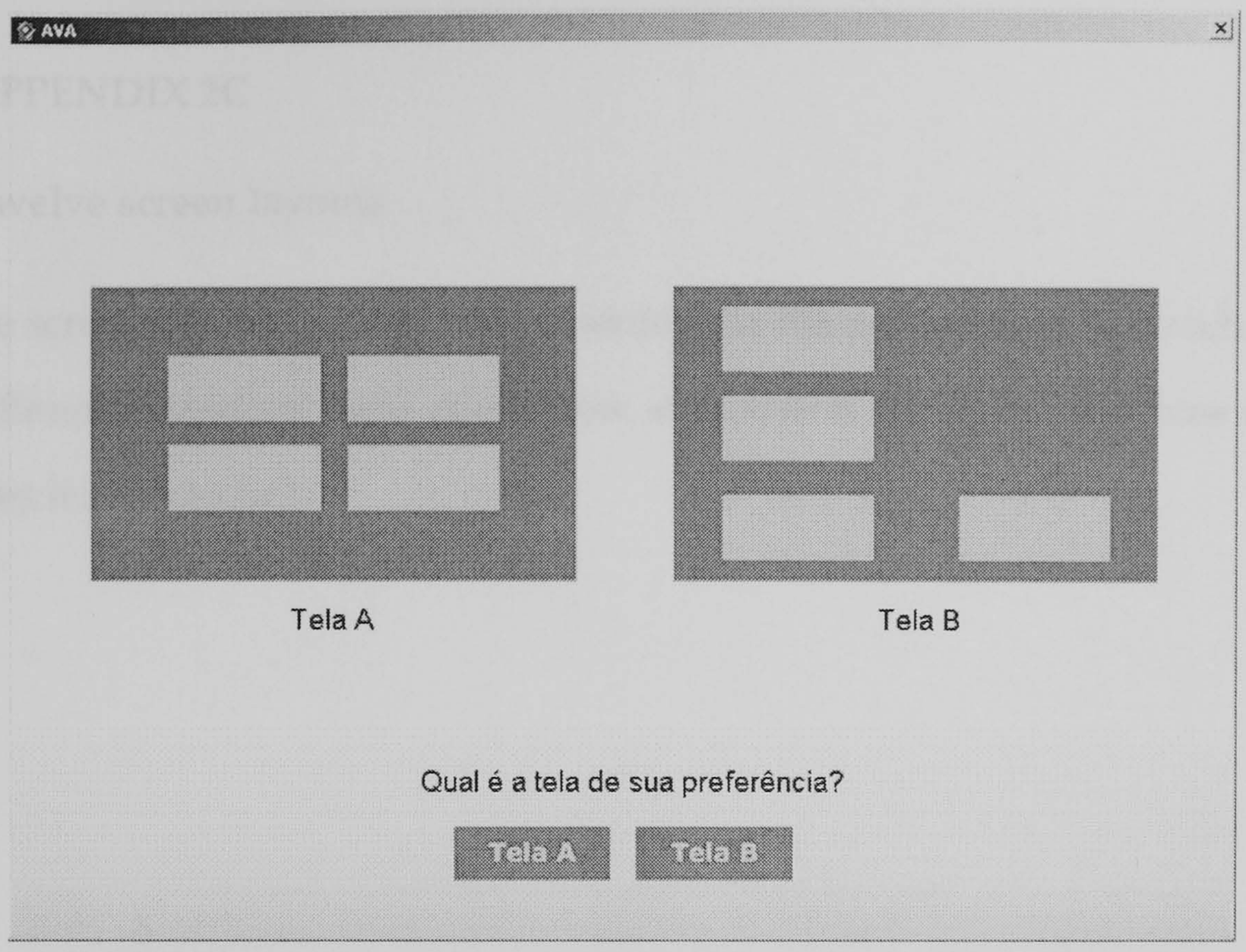


Figure A-2B.4: the screen presenting the design principle *homogeneity*

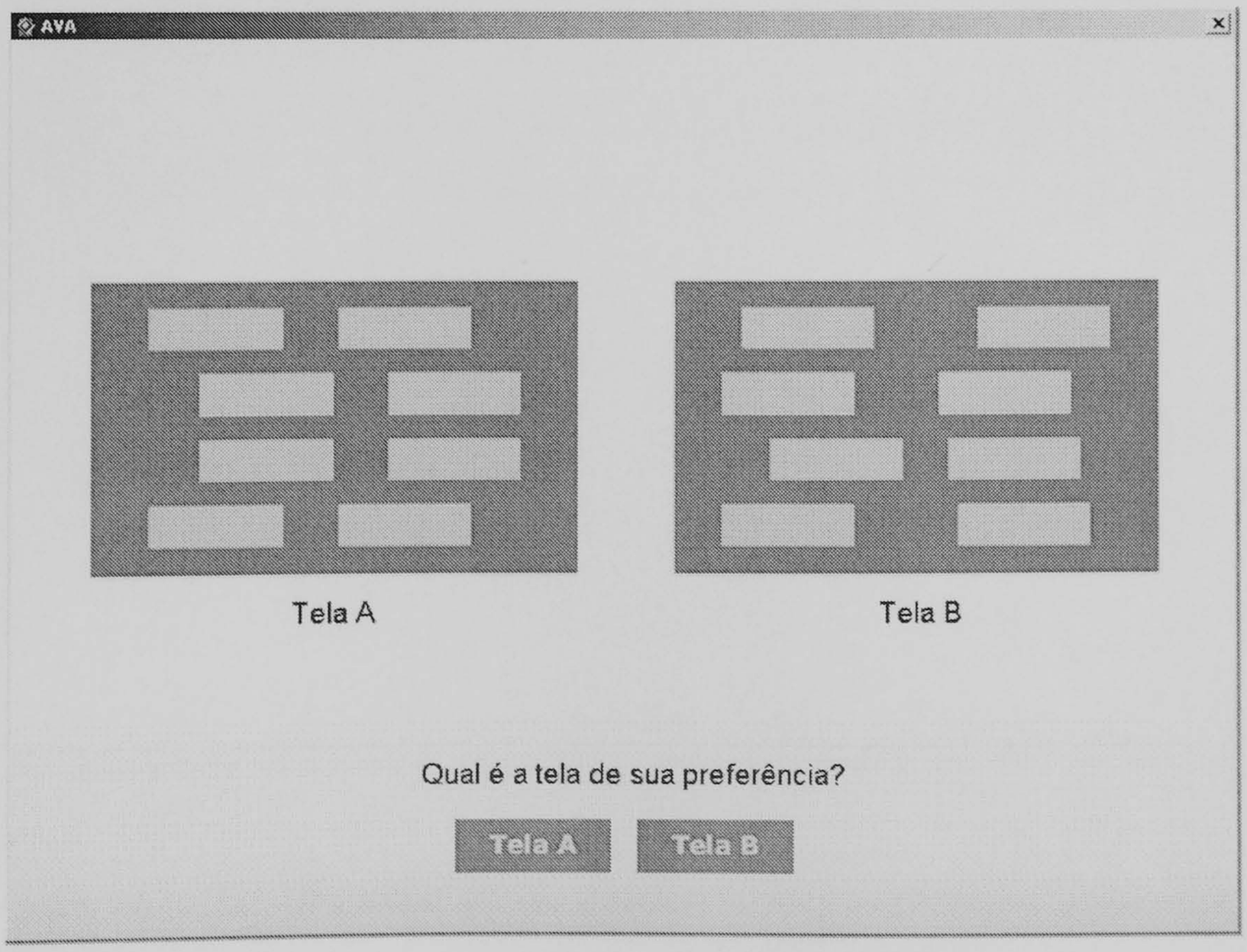


Figure A-2B.5: the screen presenting the design principle *rhythm*.

3 APPENDIX 2C

3.1 Twelve screen layouts

Twelve screen layouts as they are presented for the participants. For each screen two different questions were asked: how attractive is the layout and how easy to use does it seem to be?

home set of pages

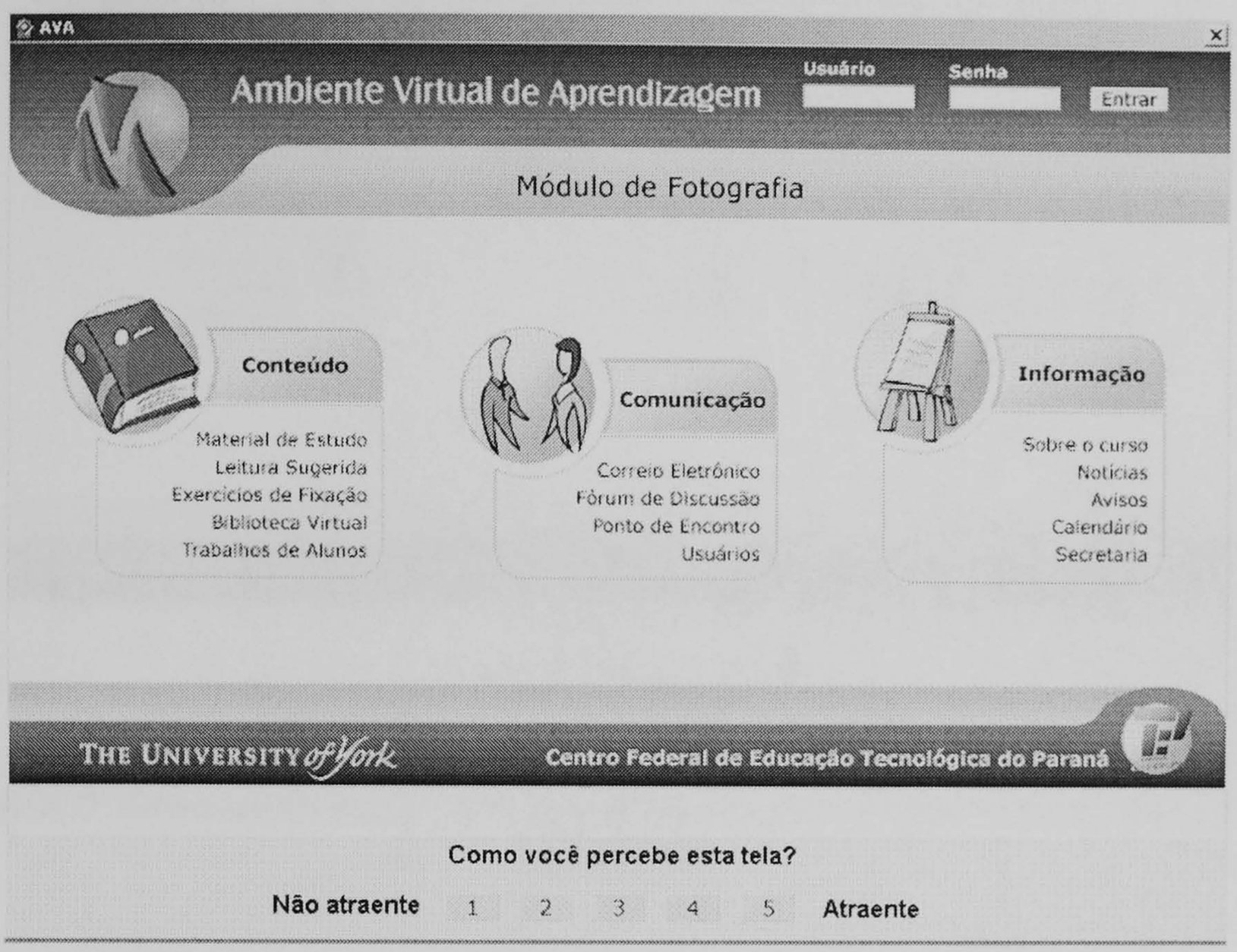


Figure A-2C.1: Screen layout that applies all the design principles.

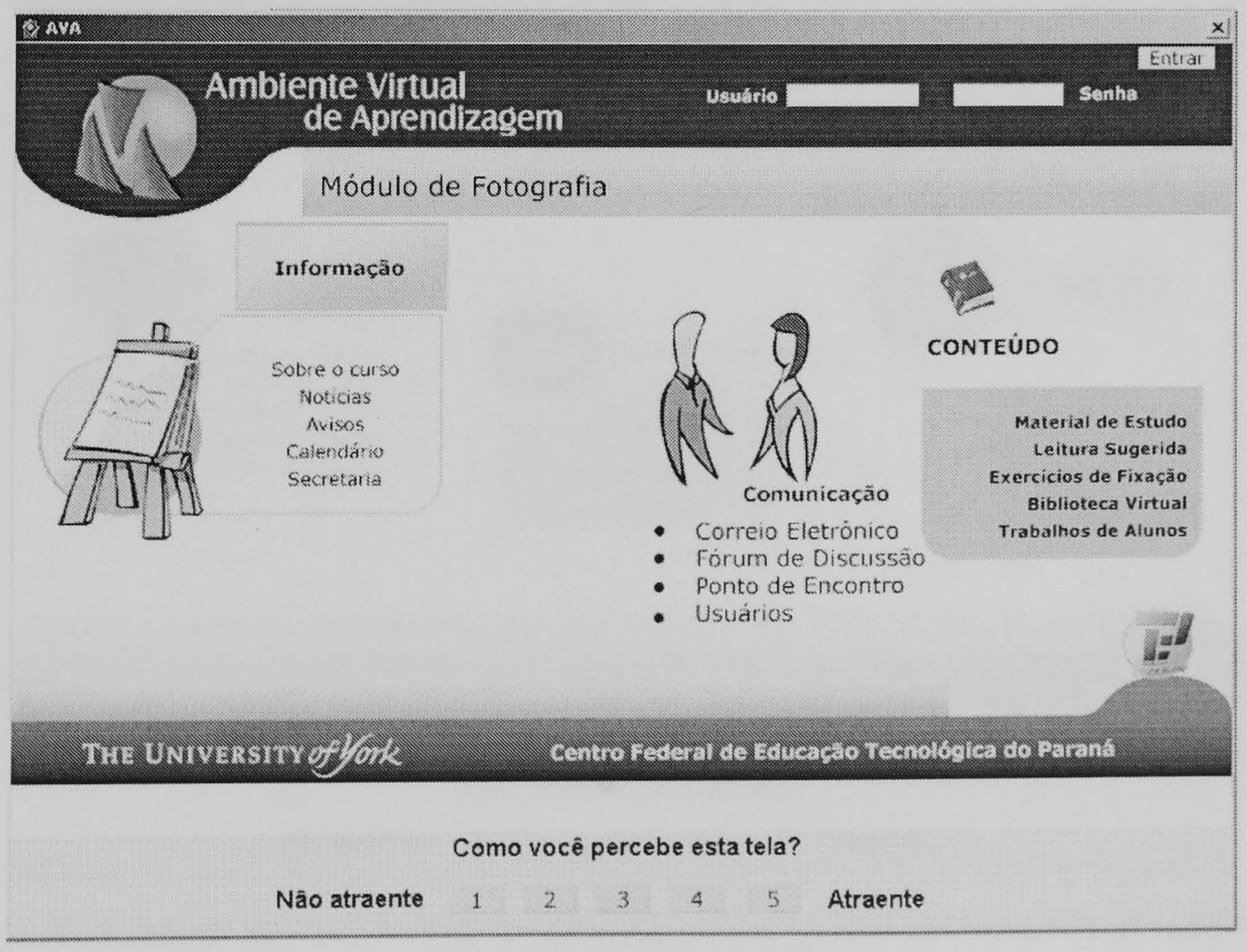


Figure A-2C.2: Screen layout that violates all the design principles.

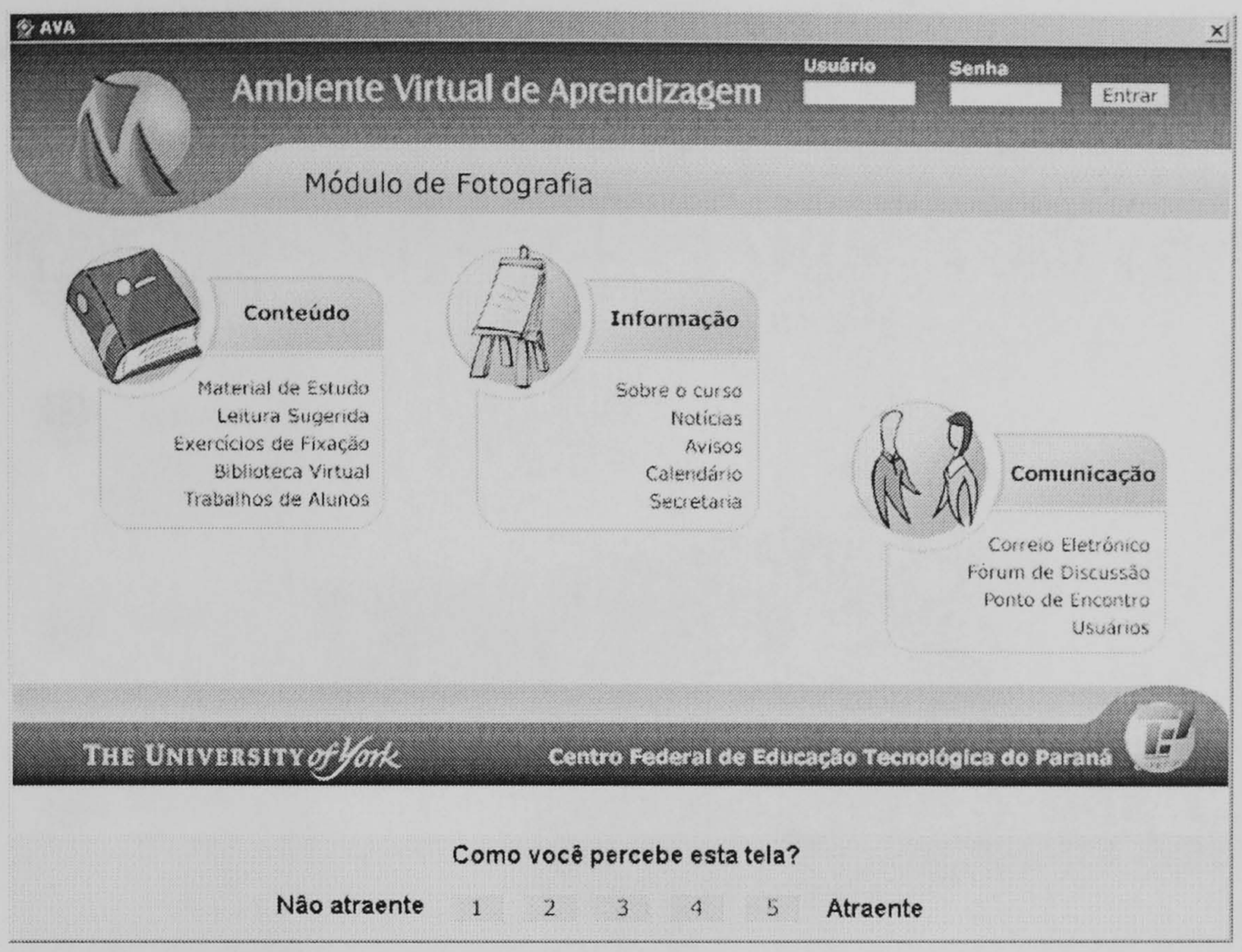


Figure A-2C.3: Screen layout that applies unity, proportion and homogeneity and violates balance and rhythm.

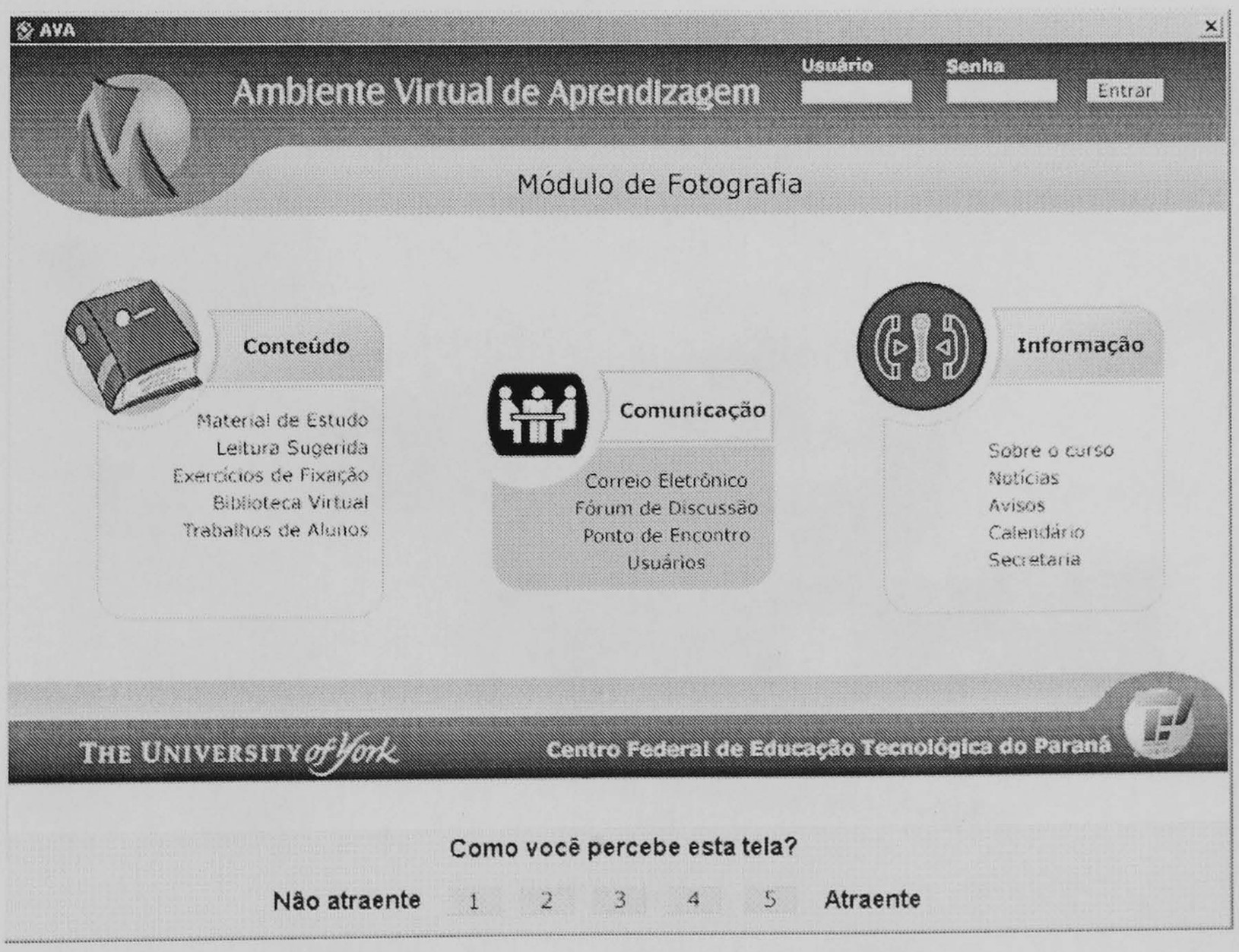


Figure A-2C.4: Screen layout that applies balance and rhythm and violates unity, proportion and homogeneity.

material set of pages

Figure A-2C.5: Screen layout that applies all the design principles.

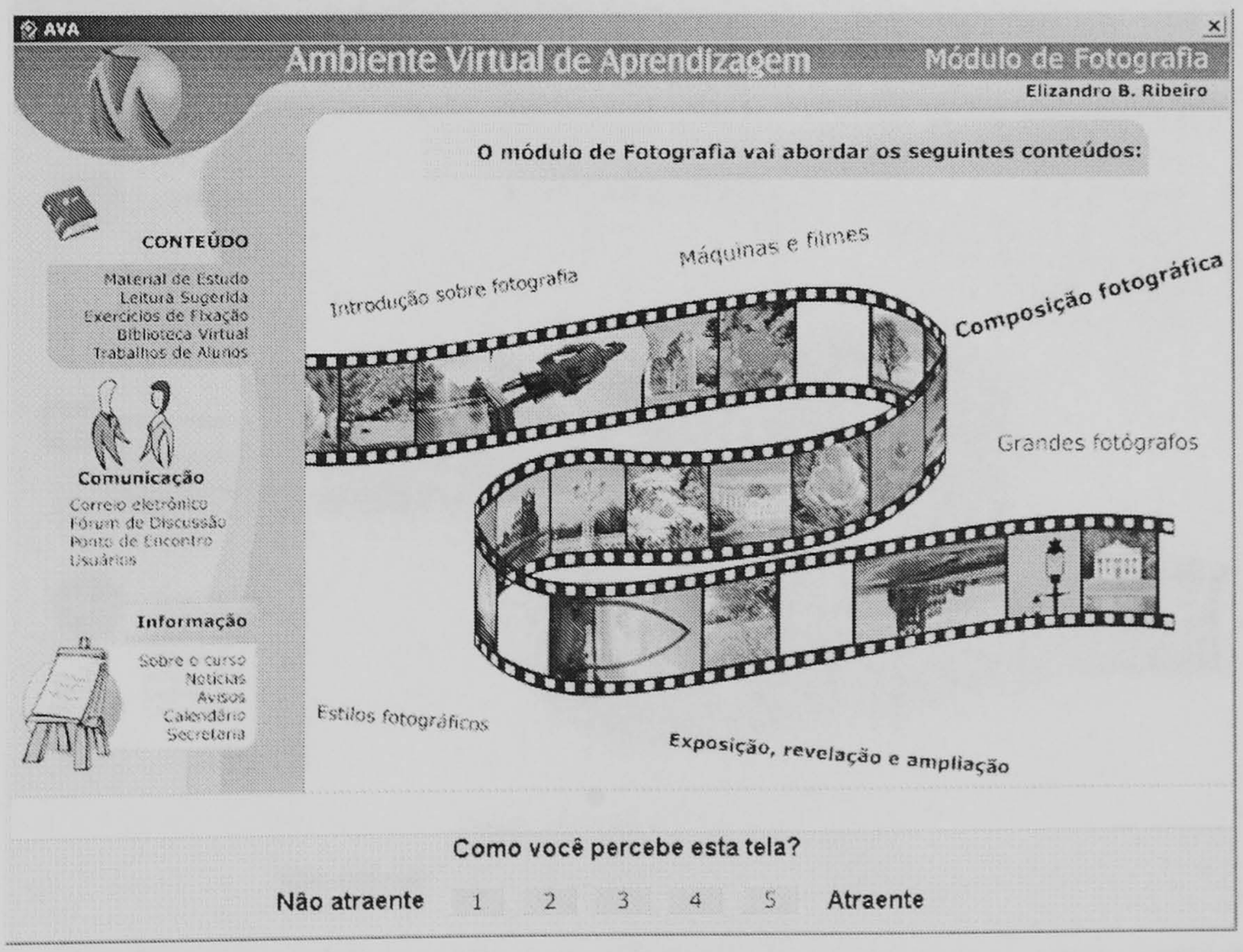


Figure A-2C.6: Screen layout that violates all the design principles.

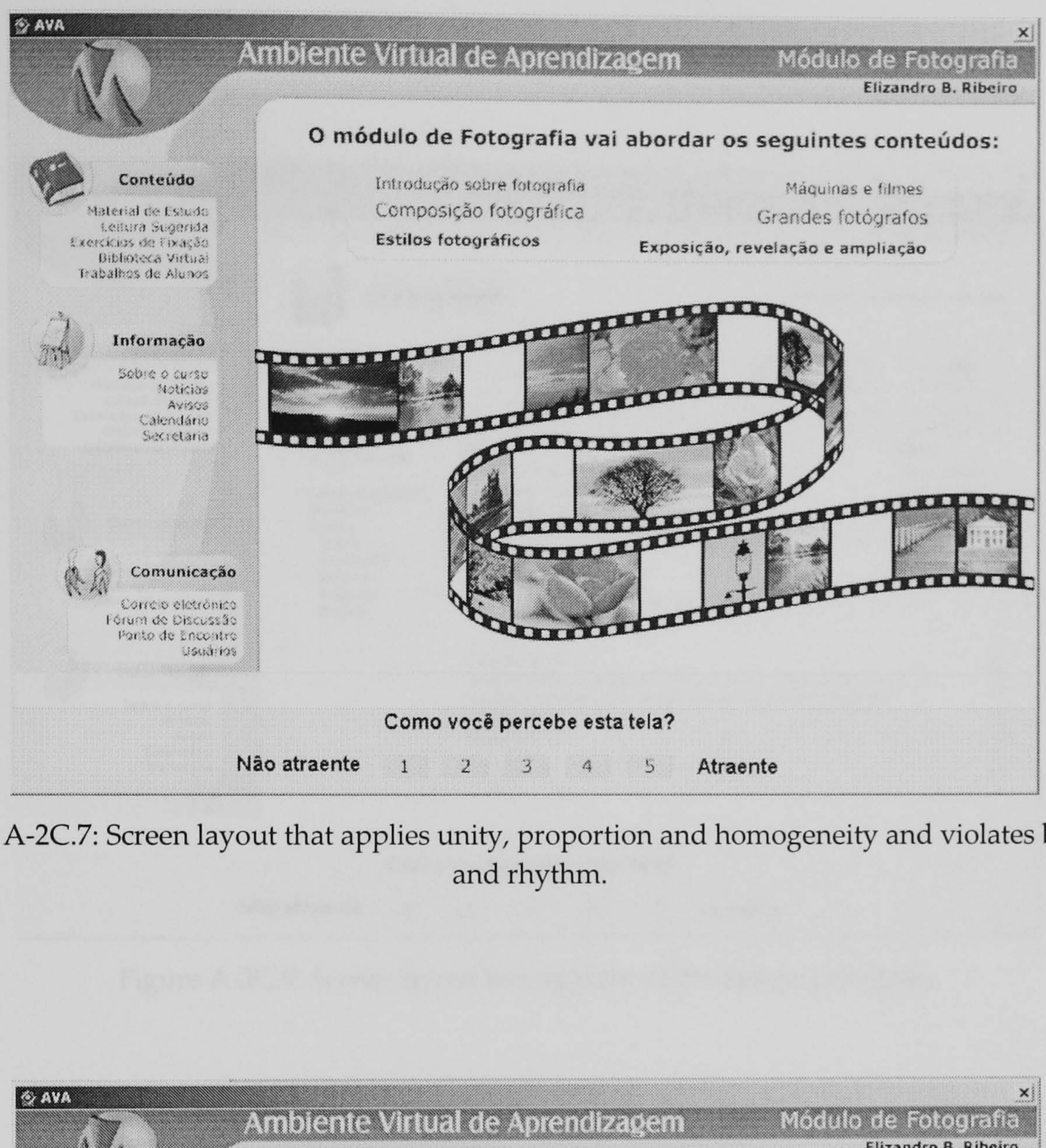


Figure A-2C.7: Screen layout that applies unity, proportion and homogeneity and violates balance and rhythm.

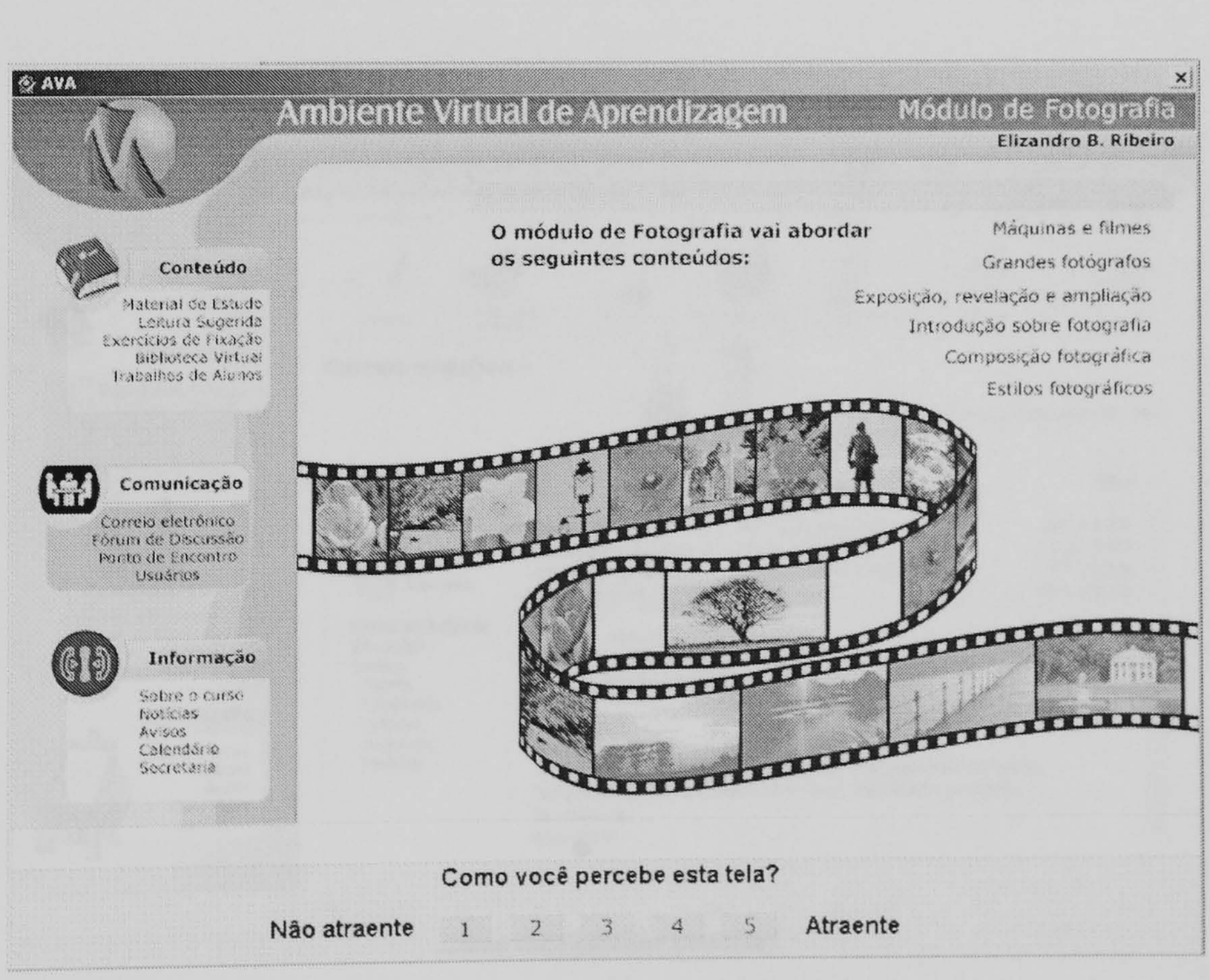


Figure A-2C.8: Screen layout that applies balance and rhythm and violates unity, proportion and homogeneity.

e-mail set of pages

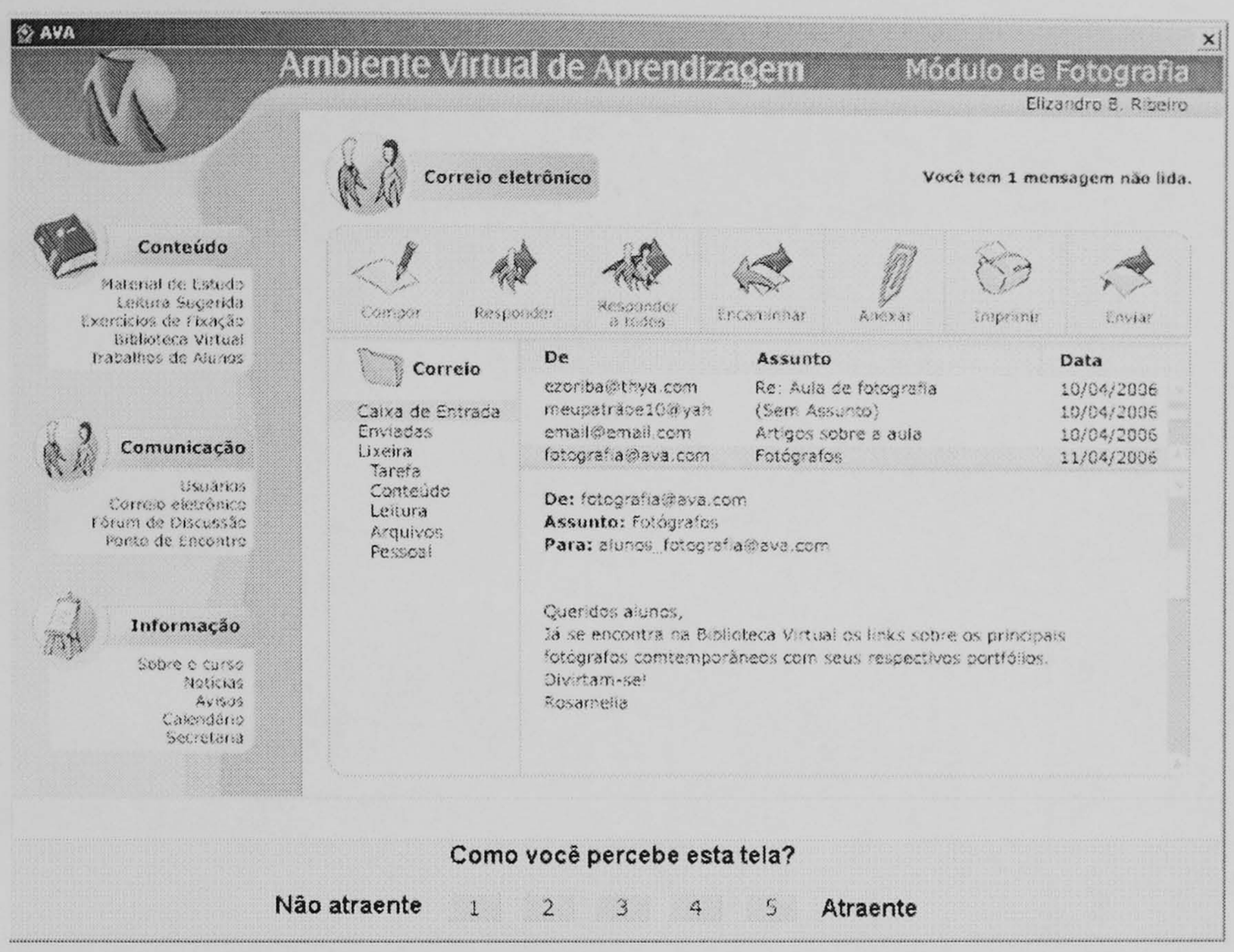


Figure A-2C.9: Screen layout that applies all the design principles.

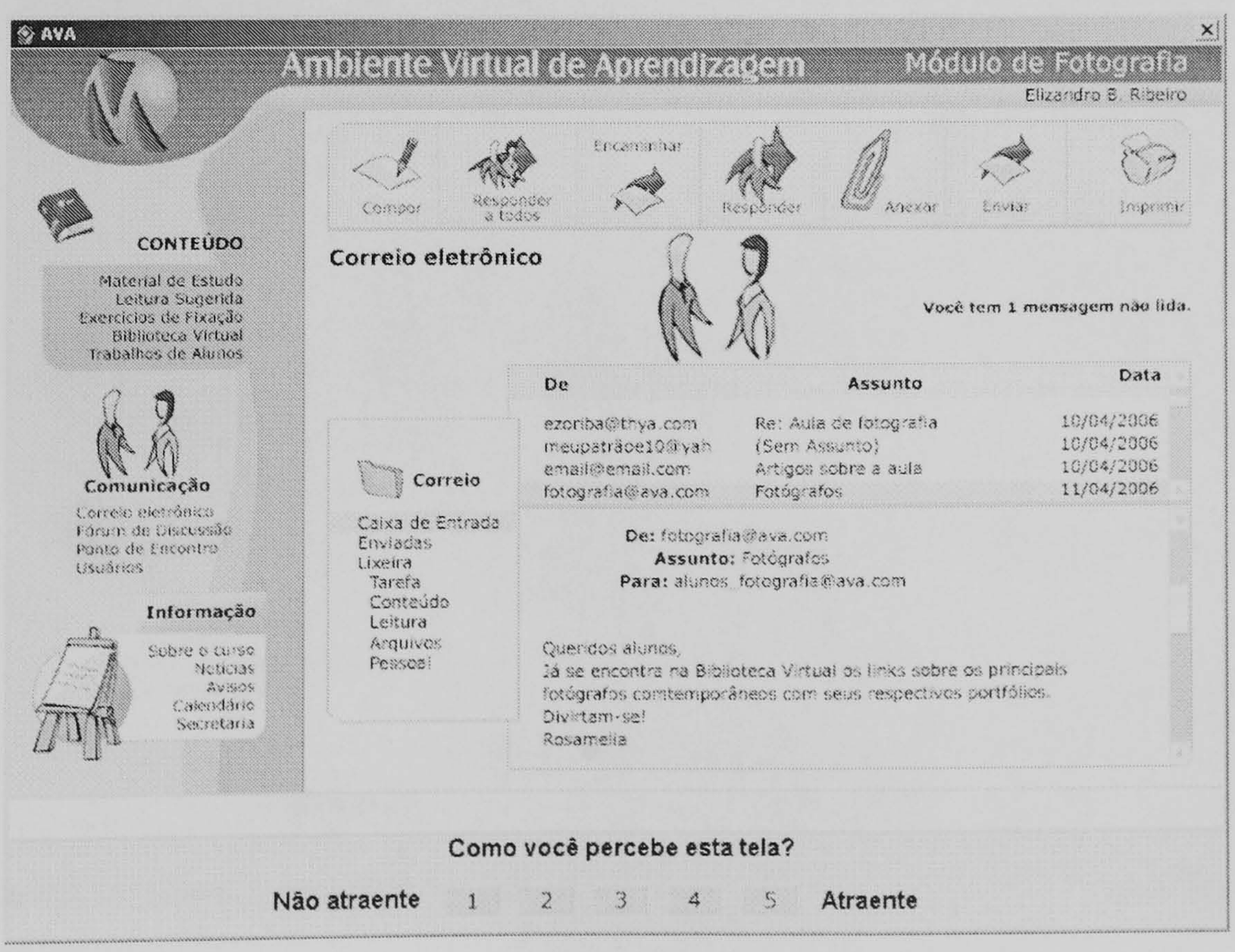


Figure A-2C.10: Screen layout that violates all the design principles.

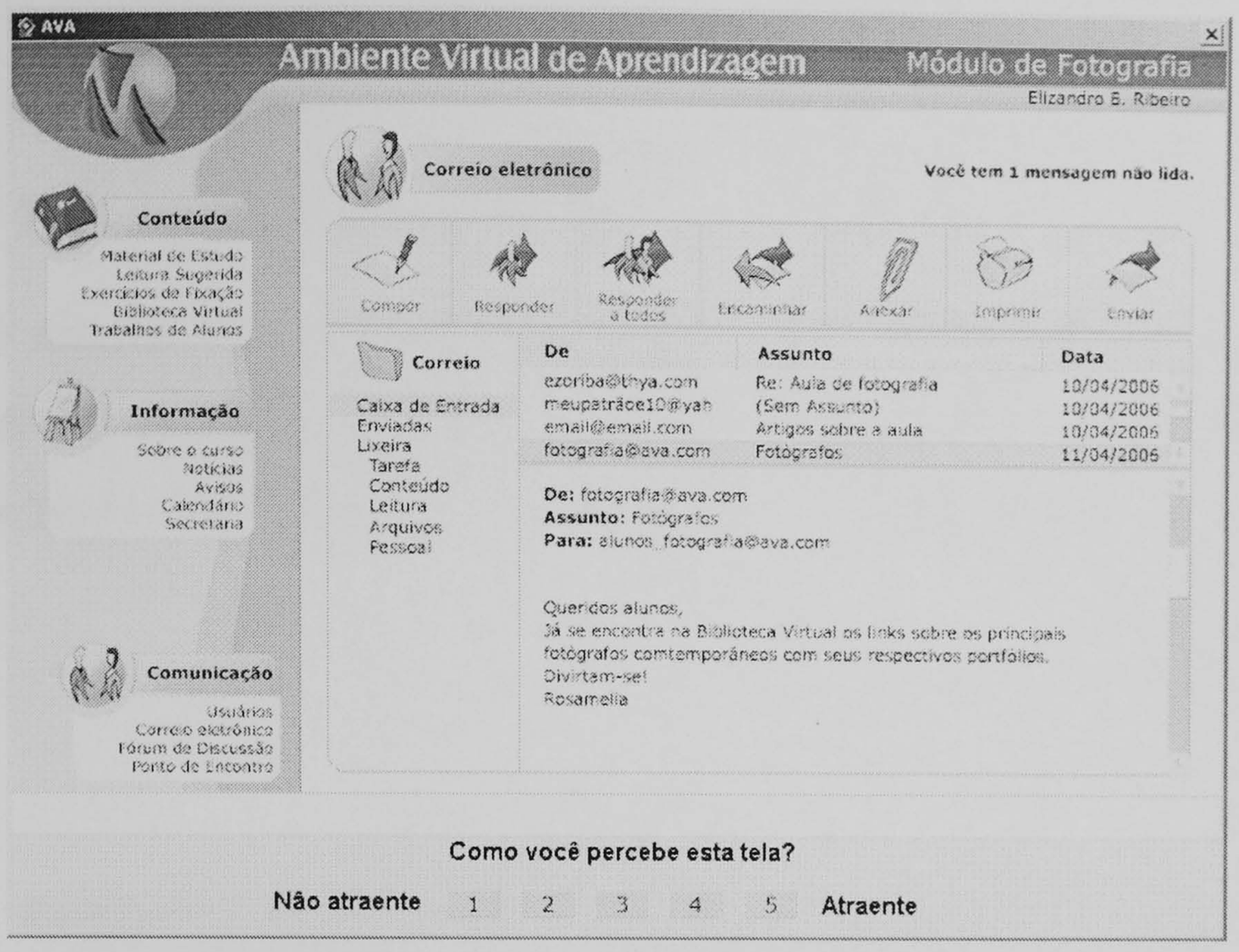


Figure A-2C.11: Screen layout that applies unity, proportion and homogeneity and violates balance and rhythm.

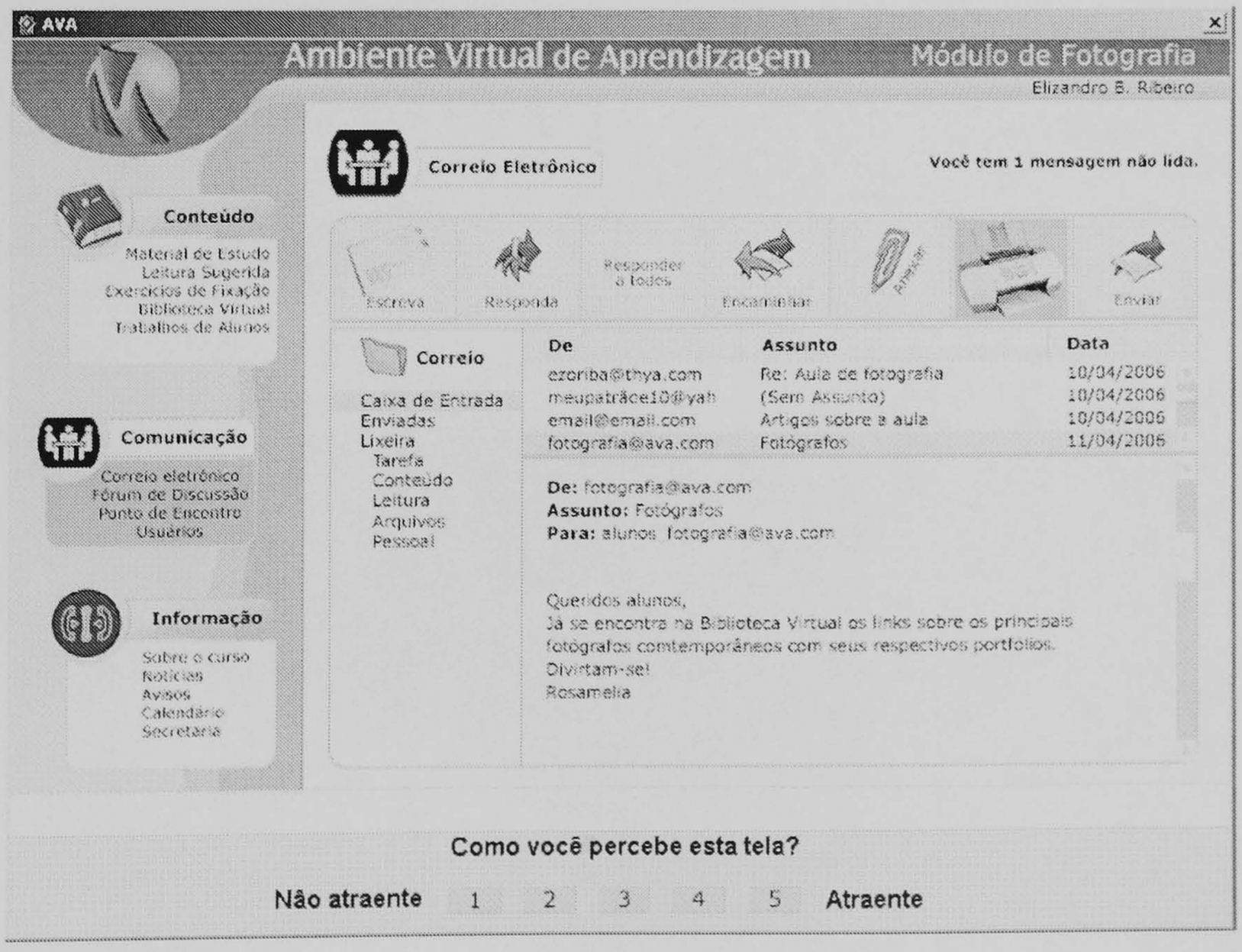


Figure A-2C.12: Screen layout that applies balance and rhythm and violates unity, proportion and homogeneity.

4 APPENDIX 2D

4.1 Two alternative forced-choice

Two different screen layouts were shown on the same page. The participants needed to choose the one they found to be more attractive and for the second time the one they perceived as easier to use.

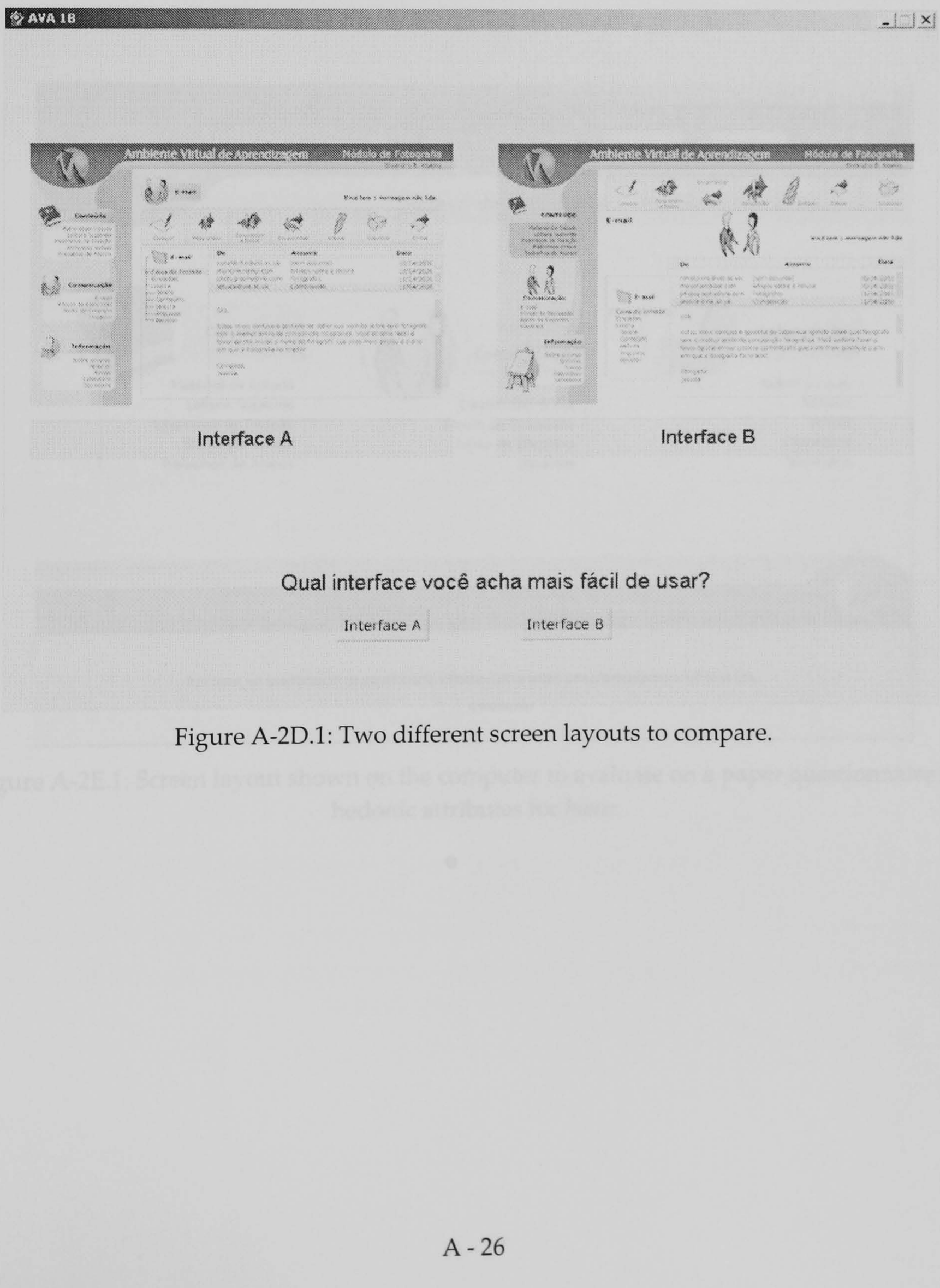


Figure A-2D.1: Two different screen layouts to compare.

5 APPENDIX 2E

The three screens that applied all design principles were presented on the computer monitor while the participant rated the hedonic attributes for each one on paper.

Example of the questionnaire for each one of the three *sets of pages* are also presented here.

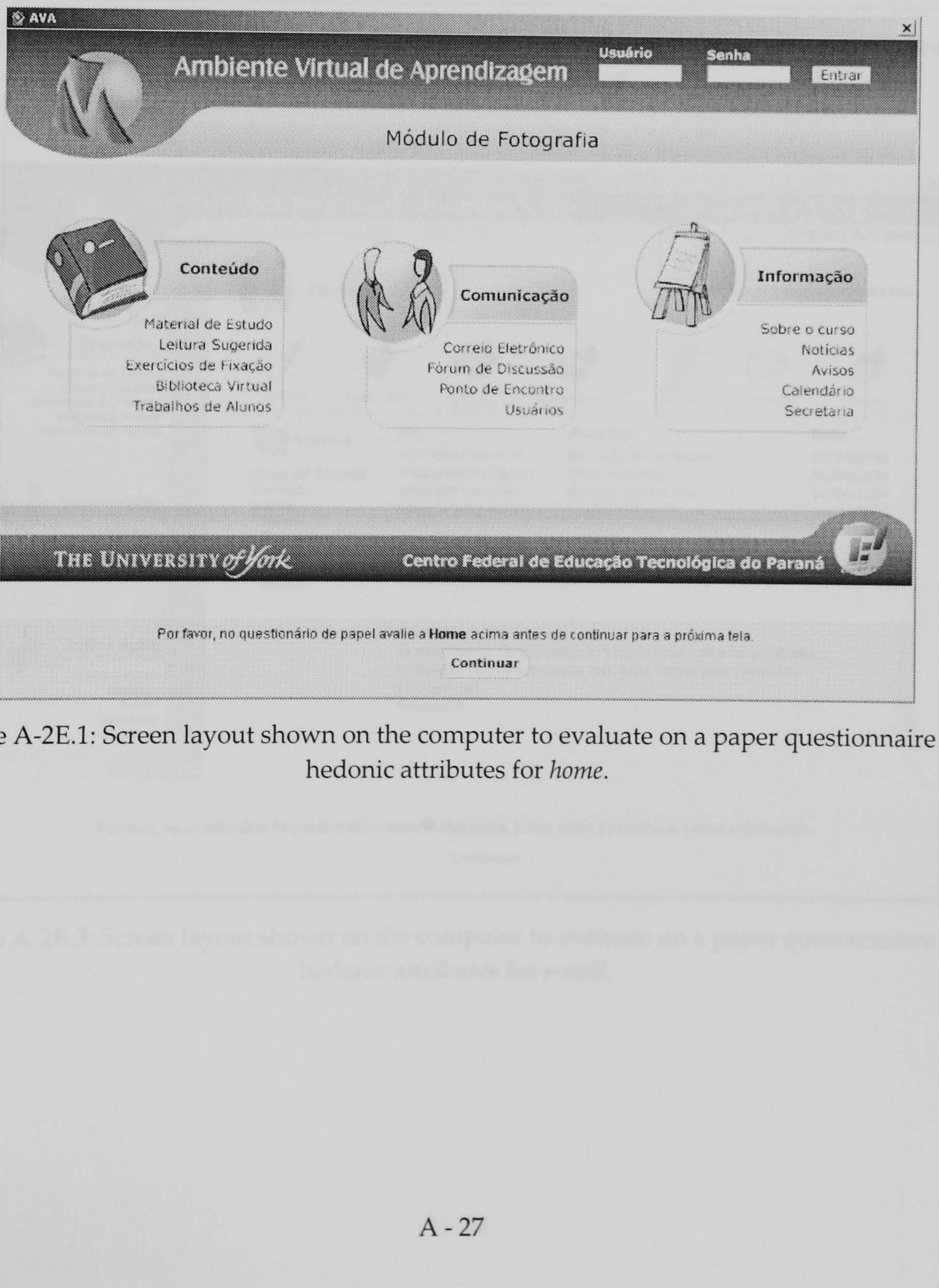


Figure A-2E.1: Screen layout shown on the computer to evaluate on a paper questionnaire the hedonic attributes for *home*.

Figure A-2E.2: Screen layout shown on the computer to evaluate on a paper questionnaire the hedonic attributes for *material*.

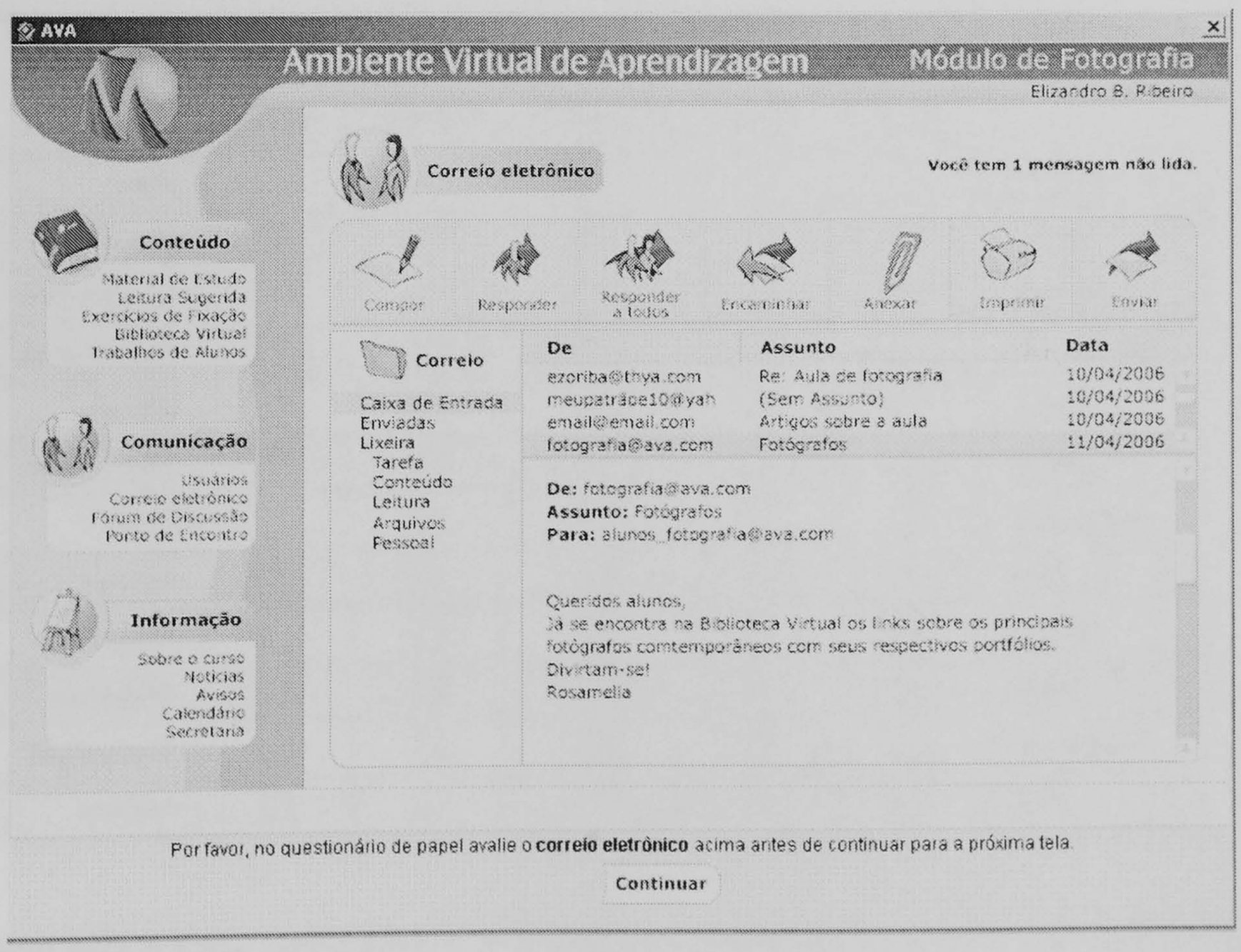
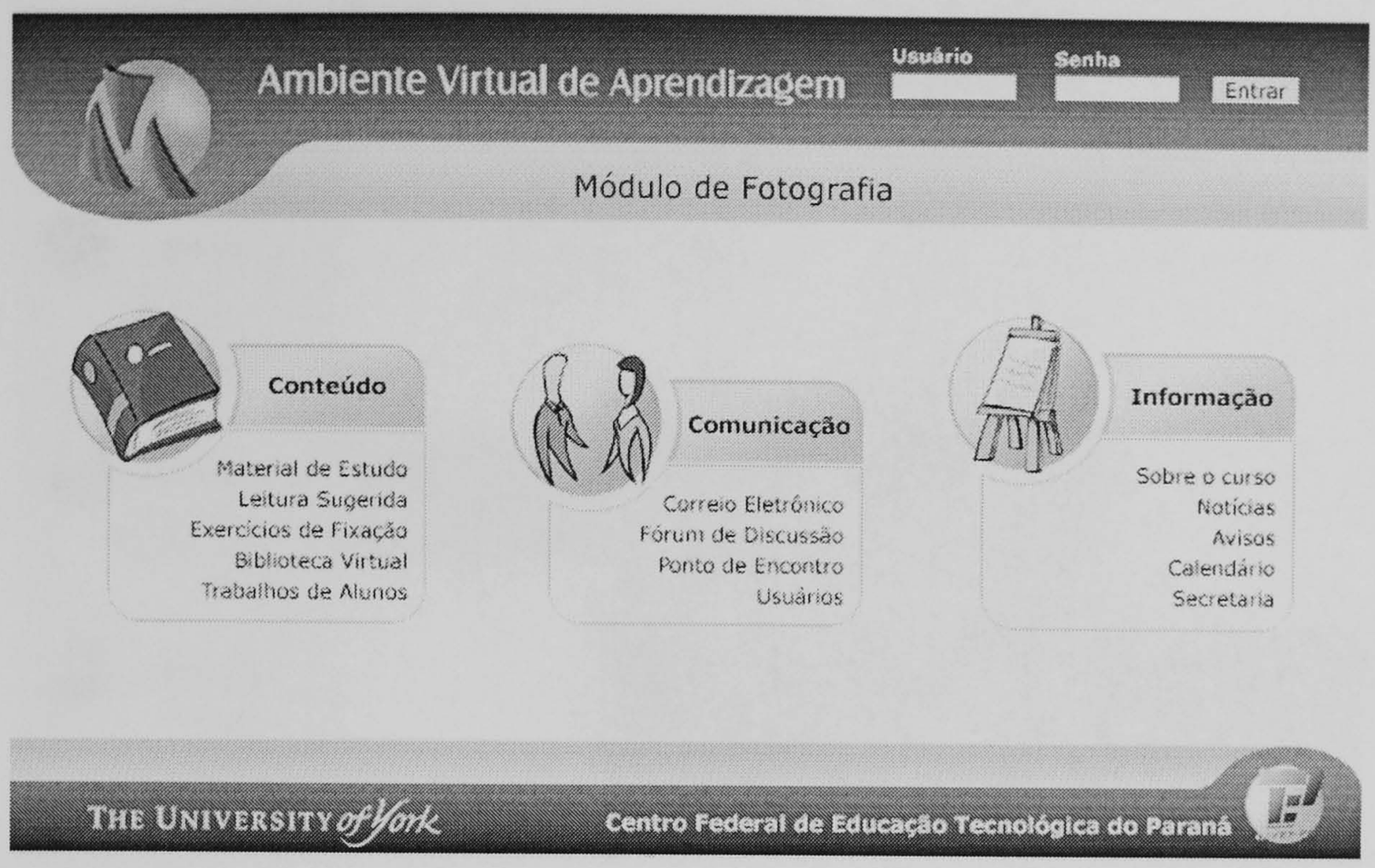


Figure A-2E.3: Screen layout shown on the computer to evaluate on a paper questionnaire the hedonic attributes for *e-mail*.

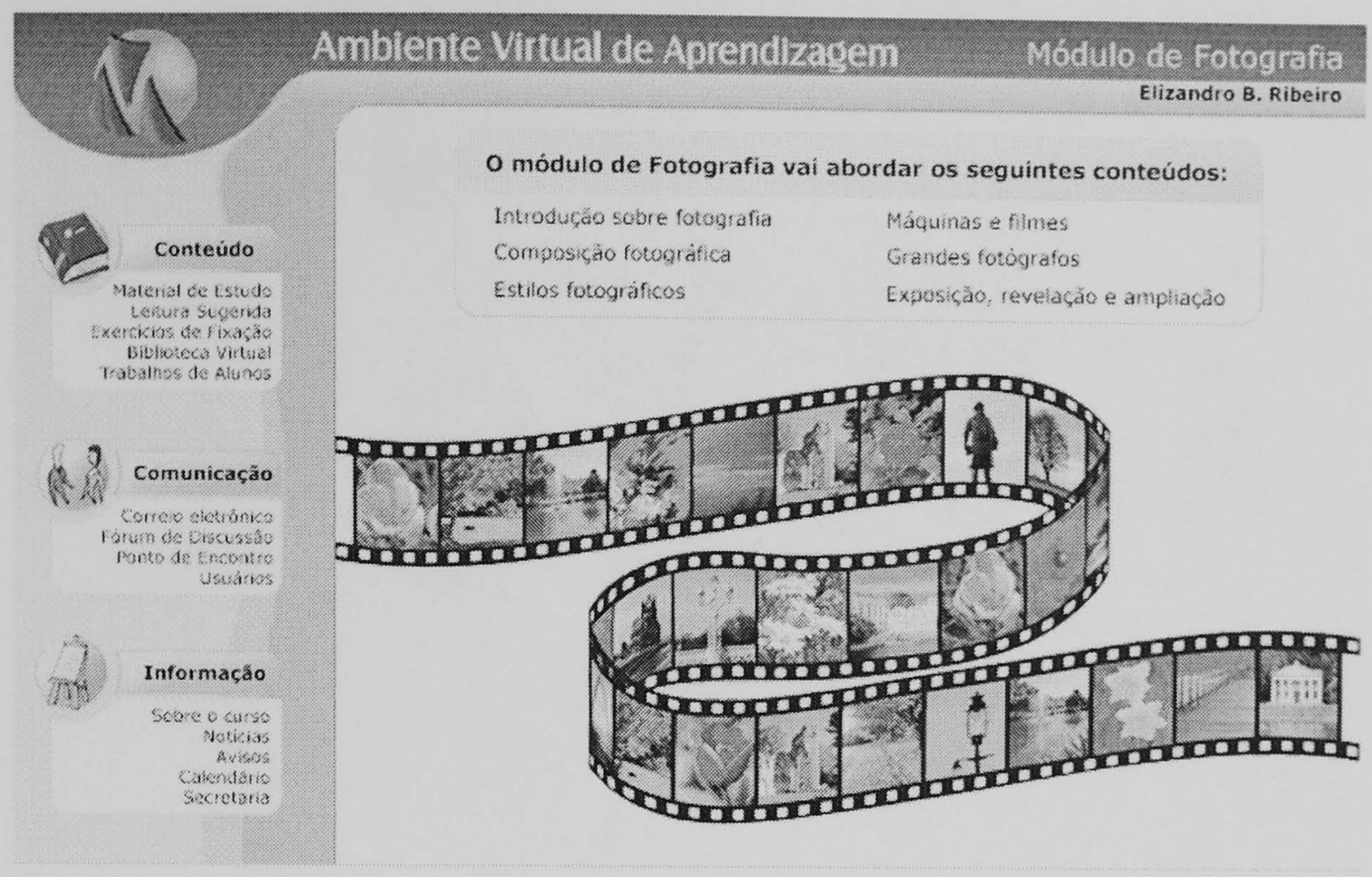


Tela 1 (Home)

Por favor, indique suas emoções a respeito das qualidades do *layout* da 1ª tela.

	Muito	Pouco	Indiferente	Pouco	Muito	
velho	☐	☐	☐	☐	☐	moderno
barato	☐	☐	☐	☐	☐	caro
extravagante	☐	☐	☐	☐	☐	clássico
diminui valor	☐	☐	☐	☐	☐	adiciona valor
padrão	☐	☐	☐	☐	☐	criativo
conservador	☐	☐	☐	☐	☐	inovador
chato	☐	☐	☐	☐	☐	interessante
comum	☐	☐	☐	☐	☐	novo
complicado	☐	☐	☐	☐	☐	simples
carregado	☐	☐	☐	☐	☐	direto
imprevisível	☐	☐	☐	☐	☐	previsível
confuso	☐	☐	☐	☐	☐	claro

Figure A-2E.4: Paper questionnaire (in Portuguese) to evaluate the hedonic attributes for *home*.

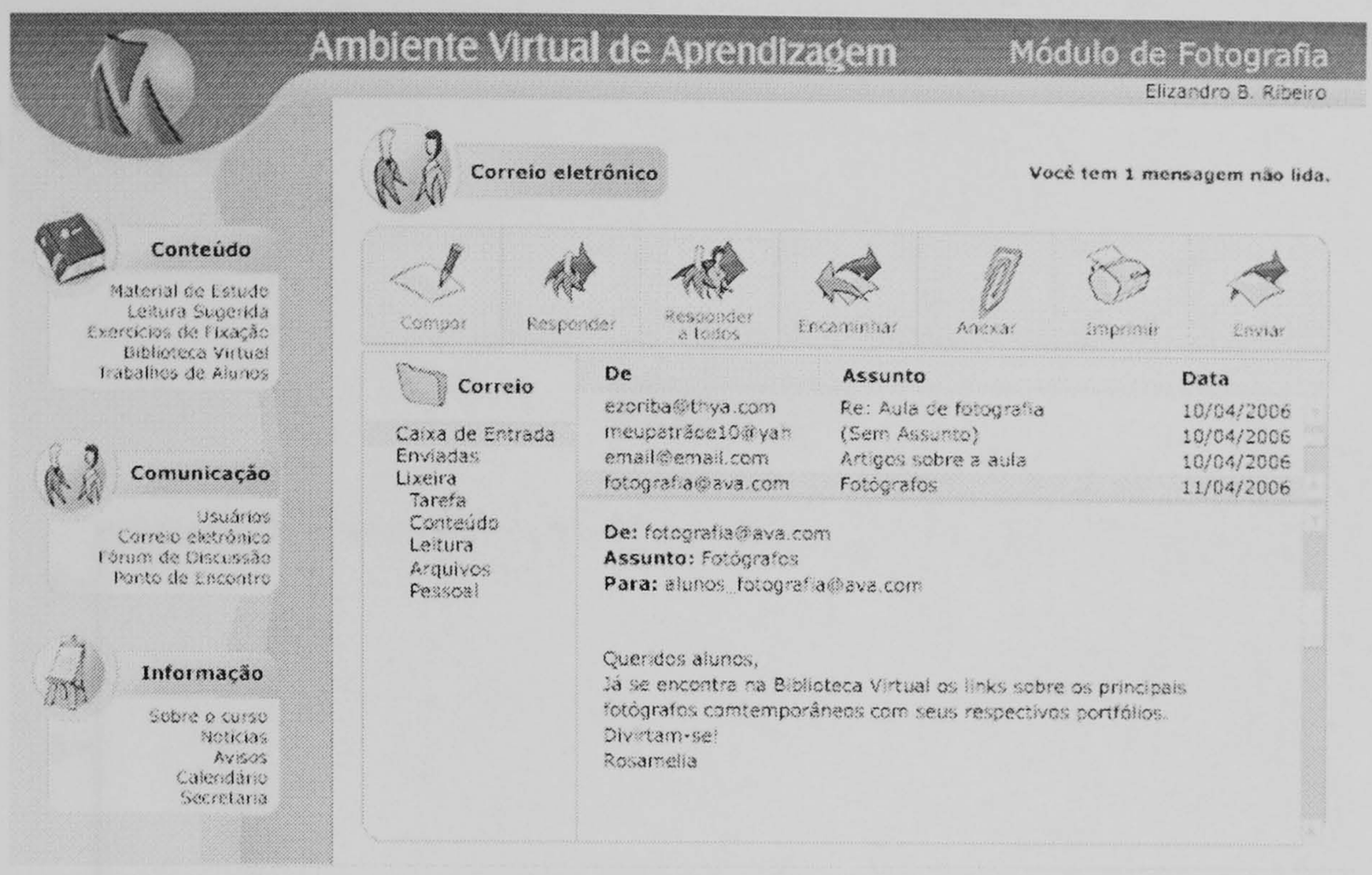


Tela 2 (Conteúdo)

Por favor, indique suas emoções a respeito das qualidades do *layout* da 2ª tela.

	Muito	Pouco	Indiferente	Pouco	Muito	
velho	☐	☐	☐	☐	☐	moderno
barato	☐	☐	☐	☐	☐	caro
extravagante	☐	☐	☐	☐	☐	clássico
diminui valor	☐	☐	☐	☐	☐	adiciona valor
padrão	☐	☐	☐	☐	☐	criativo
conservador	☐	☐	☐	☐	☐	inovador
chato	☐	☐	☐	☐	☐	interessante
comum	☐	☐	☐	☐	☐	novo
complicado	☐	☐	☐	☐	☐	simples
carregado	☐	☐	☐	☐	☐	direto
imprevisível	☐	☐	☐	☐	☐	previsível
confuso	☐	☐	☐	☐	☐	claro

Figure A-2E.5: Paper questionnaire (in Portuguese) to evaluate the hedonic attributes for *material*.



Tela 3 (Correio Eletrônico)

Por favor, indique suas emoções a respeito das qualidades do *layout* da 3ª tela.

	Muito	Pouco	Indiferente	Pouco	Muito	
velho	☐	☐	☐	☐	☐	moderno
barato	☐	☐	☐	☐	☐	caro
extravagante	☐	☐	☐	☐	☐	clássico
diminui valor	☐	☐	☐	☐	☐	adiciona valor
padrão	☐	☐	☐	☐	☐	criativo
conservador	☐	☐	☐	☐	☐	inovador
chato	☐	☐	☐	☐	☐	interessante
comum	☐	☐	☐	☐	☐	novo
complicado	☐	☐	☐	☐	☐	simples
carregado	☐	☐	☐	☐	☐	direto
imprevisível	☐	☐	☐	☐	☐	previsível
confuso	☐	☐	☐	☐	☐	claro

Figure A-2E.6: Paper questionnaire (in Portuguese) to evaluate the hedonic attributes for *e-mail*.

6 APPENDIX 2F

6.1 Screeplot

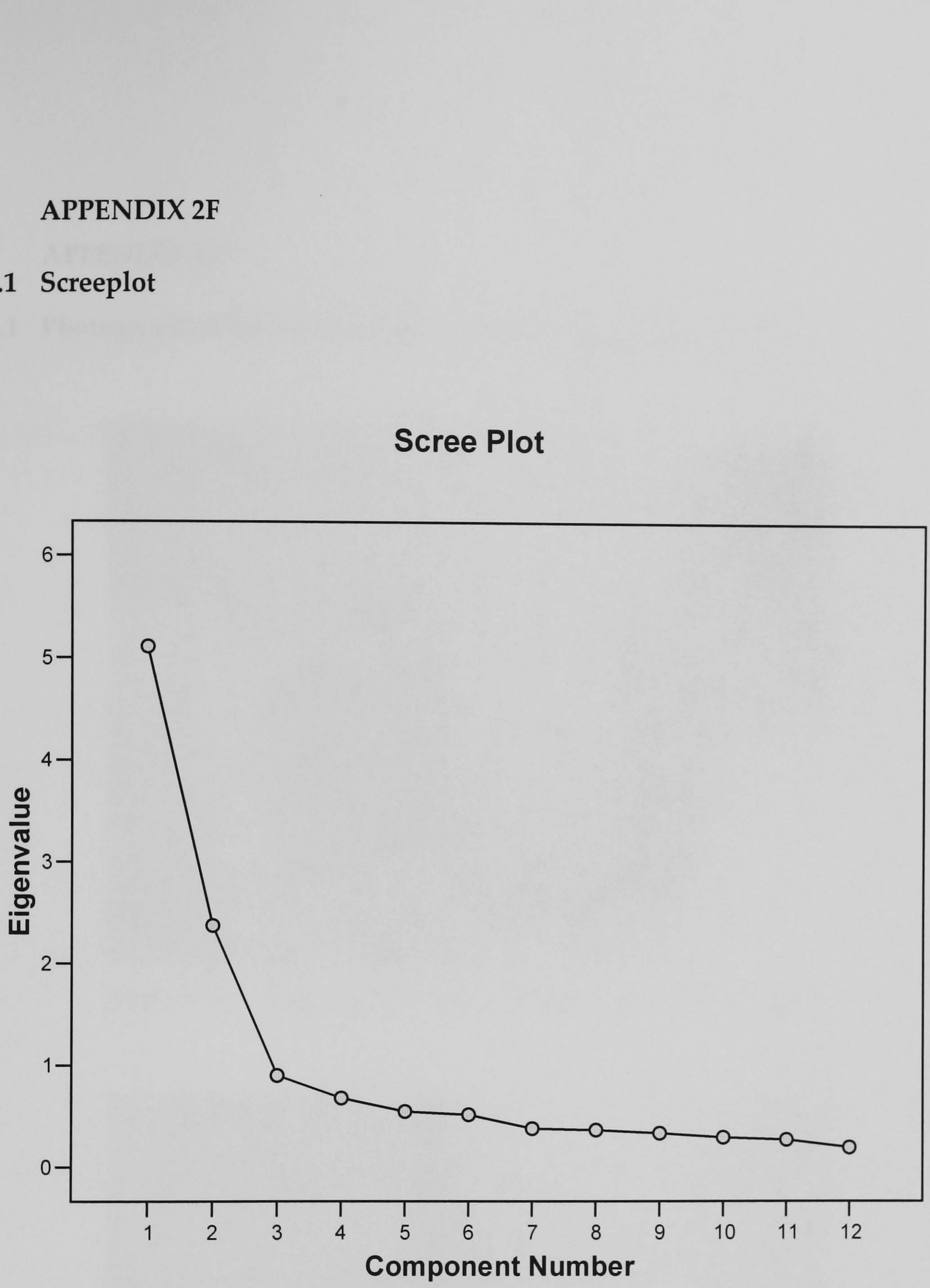


Figure 2-AF.4: The screeplot from the factor analysis.

7 APPENDIX 2F

7.1 Photograph of the environment condition during the experiment.

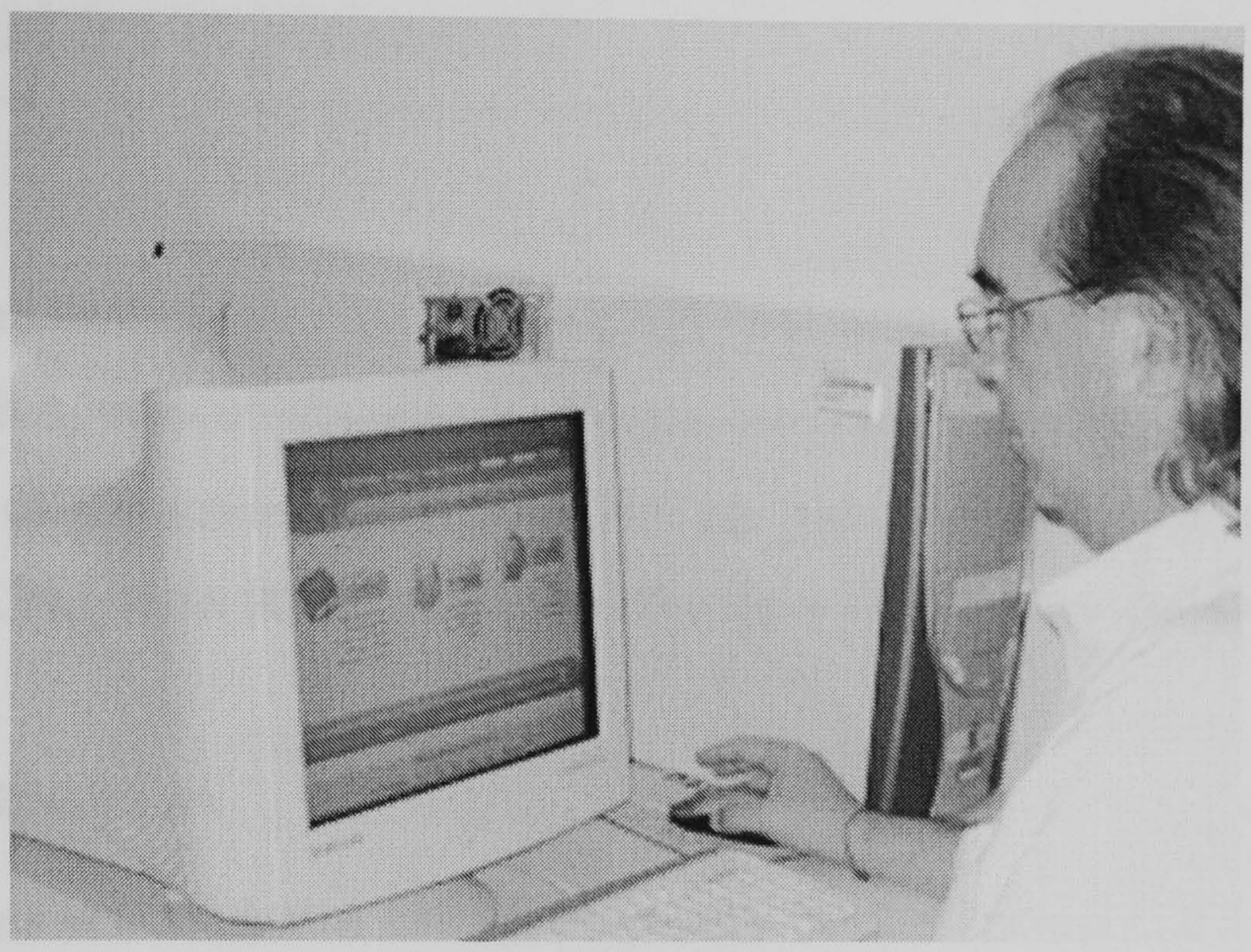


Figure A-2F.1: Photograph showing one participant during the experiment.

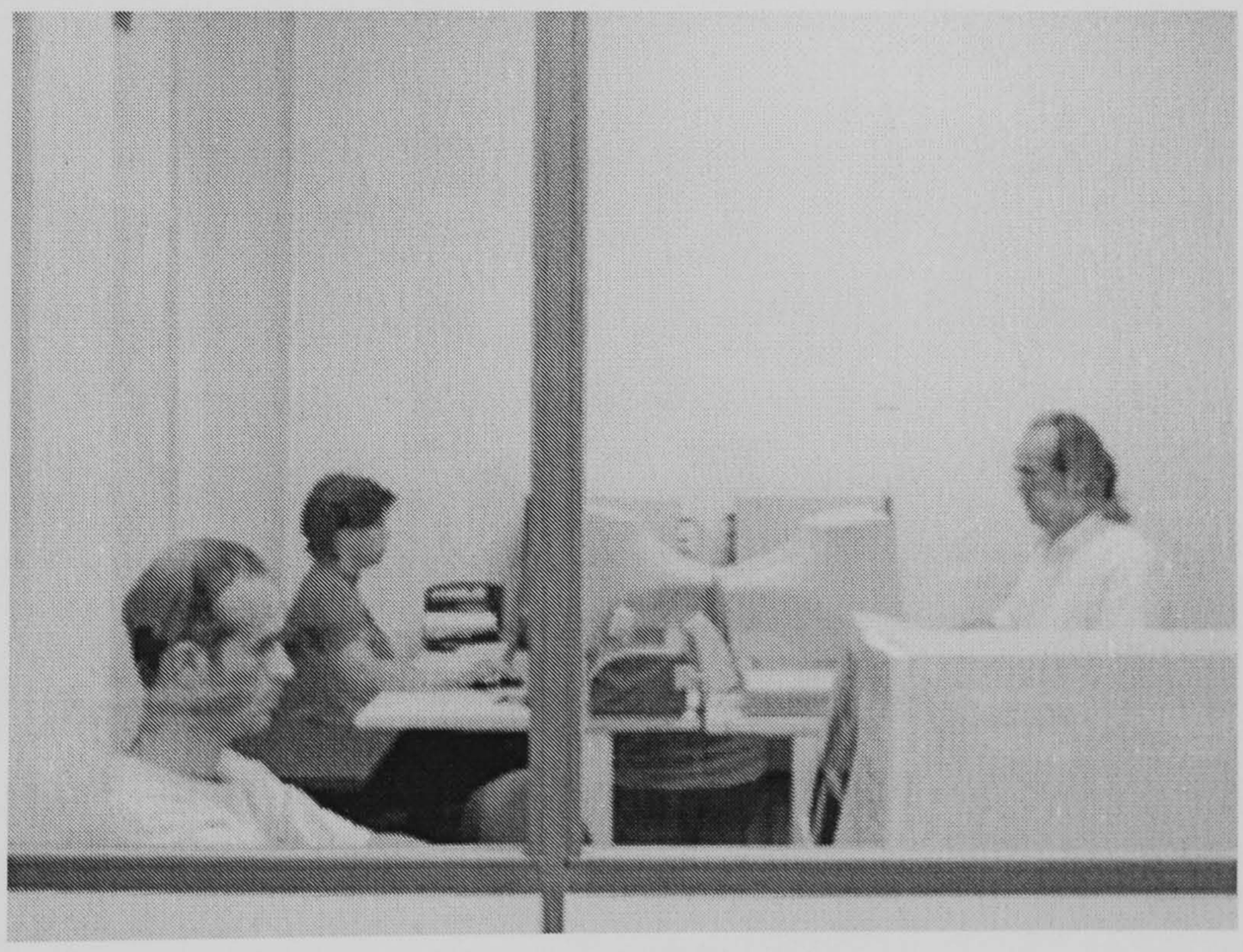


Figure A-2F.2: Photograph showing three participants during the experiment.

Appendix 3

Material for experiment 2

This appendix illustrated the screen layouts used in experiment 2. Appendix 3A presents the letters of information and consent forms. Appendix 3B presents an example of the screen layouts used for the *high aesthetics* and *low aesthetics* condition. Appendix 3C shows the two alternative forced-choice layouts.

1 APPENDIX 3A

1.1 Letters of information and consent forms

Aesthetics and Usability of Virtual Learning Environments

Letter of Information for the Participants

CEFET-PR is participating in a research project called 'Aesthetics and Usability of Virtual Learning Environments'. It intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

As part of this research, we will ask you to complete a task using the proposed Virtual Learning Environment and answer some questions about them using a rating scale. The questions intend to collect information about your perception of aesthetics and usability. This should not involve any risk or inconvenience to you.

All participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. All the data collected will be stored and used only for the purpose of the research. The data will also be anonymous and the only people who will have access to it will be the researcher and the Research Committee Members.

Any questions about the research may be addressed to:

Rosamelia Parizotto Ribeiro

Department of Psychology	LaMid – Laboratório de Mídias do CEFET-PR
University of York – Heslington	Av. 7 de Setembro, 3165
YO10 5DD – York	80.230-901 - Curitiba
Telephone: +44 (1904) 432.869	Telefone: 41 (XX) 310-4824
e-mail: R.Ribeiro@psych.york.ac.uk	e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-3A.1: Letter of information for the participants (in English).

Aesthetics and Usability of Virtual Learning Environments

Letter of information for the Institution

During a short period on 2004, students and staff of CEFET-PR will be participating in a research project called 'Aesthetics and Usability of Virtual Learning Environments'. It intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface and is undertaken experimental work to collect data in Brazil and in UK. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

As part of this research, we will ask you to complete a task using the proposed Virtual Learning Environment and answer some questions about them using a rating scale. The questions intend to collect information about their perception of aesthetics and usability. This should not involve any risk or inconvenience to them.

All participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. The data collected will be stored and used only for the purpose of the research. The data will also be anonymous and the only people who will have access to it will be the researcher and the Research Committee Members.

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80.230-901 - Curitiba
Telefone: 41 (XX) 310-4824
e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-3A.2: Letter of information for the institution (in English)

Estética e Usabilidade de Ambientes Virtuais de Aprendizagem

Carta de Informação para os Participantes

O CEFET-PR está participando de uma pesquisa sobre 'Estética e Usabilidade de Ambientes Virtuais de Aprendizagem'. A pesquisa pretende investigar a relação entre a estética e a usabilidade percebida pelo usuário de interfaces computacionais usadas como Ambientes Virtuais de Aprendizagem. Esta segunda parte irá investigar a correlação entre a usabilidade e a estética após a interação com a interface proposta desenvolvida com base no uso ou não-uso dos princípios de *design*.

Como parte desta pesquisa, será pedido aos participantes realizar uma tarefa usando o Ambiente Virtual de Aprendizagem proposto e responder algumas perguntas sobre a interface usando uma escala de avaliação. As perguntas pretendem coletar informações sobre a percepção do participante sobre a estética e a usabilidade da interface. Isto não deverá envolver nenhum risco ou inconveniente ao partipante.

Toda participação é voluntária e reserva ao participante o direito se retirar em qualquer etapa do experimento. Todos os dados coletados serão cuidadosamente guardados e usados somente para propósitos desta pesquisa. Os dados também serão anônimos e as únicas pessoas com acesso a eles serão a pesquisadora e os membros do seu Comitê de Pesquisa.

Qualquer pergunta ou dúvida sobre a pesquisa pode ser feita diretamente a pesquisadora ou encaminhada para:

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LaMid – Laboratório de Mídias do CEFET-PR
Av. 7 de Setembro, 3165
80.230-901 - Curitiba
Telefone: 41 (XX) 310-4824
e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-3A.3: Letter of information for the participants (in Portuguese)

THE UNIVERSITY *of York*

Consent from Participants

Investigator's name: Rosamelia Parizotto Ribeiro

Title of study: Aesthetics and Usability of Virtual Learning Environments.

Brief description of study: This research project intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

Declaration of consent

I have read the accompanying letter and I have been informed about the aims and procedures involved in the experiment in which I am about to participate. I understand that the participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. Any information that I have provided as part of the study will be confidential and my identity removed unless I agree otherwise.

I agree to participate in this Research.

Printed name: _____

Signature: _____

Category: _____

e-mail address: _____

Date: _____

Figure A-3A.4: Consent from the participants (in English)

THE UNIVERSITY *of York*

Consent from the Head of the Educational Institution

Investigator's name: Rosamelia Parizotto Ribeiro

Title of study: Aesthetics and Usability of Virtual Learning Environments.

Brief description of study: This research project intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

Declaration of consent

I have read the accompanying letter and I have been informed about the aims and procedures involved in the research project described above. I reserve the right to withdraw any participant at any stage in the proceedings. I understand that the information gained will be anonymous and that the participants' name will not be in any materials used in the research, unless the participants agree otherwise.

I agree that the students and staff of this Educational Institution participate in this Research.

Printed name: _____

Role: _____

Signature: _____

e-mail address: _____

Date: _____

Figure A-3A.5: Consent from the head of the educational institution (in English)

2 APPENDIX 3C

2.1 Two aesthetics conditions

This appendix presents the screen layouts used for the *low* and *high aesthetics* condition. There is an example from each *set of pages* used to develop the prototype.

Screen layouts used for the *high aesthetic* condition

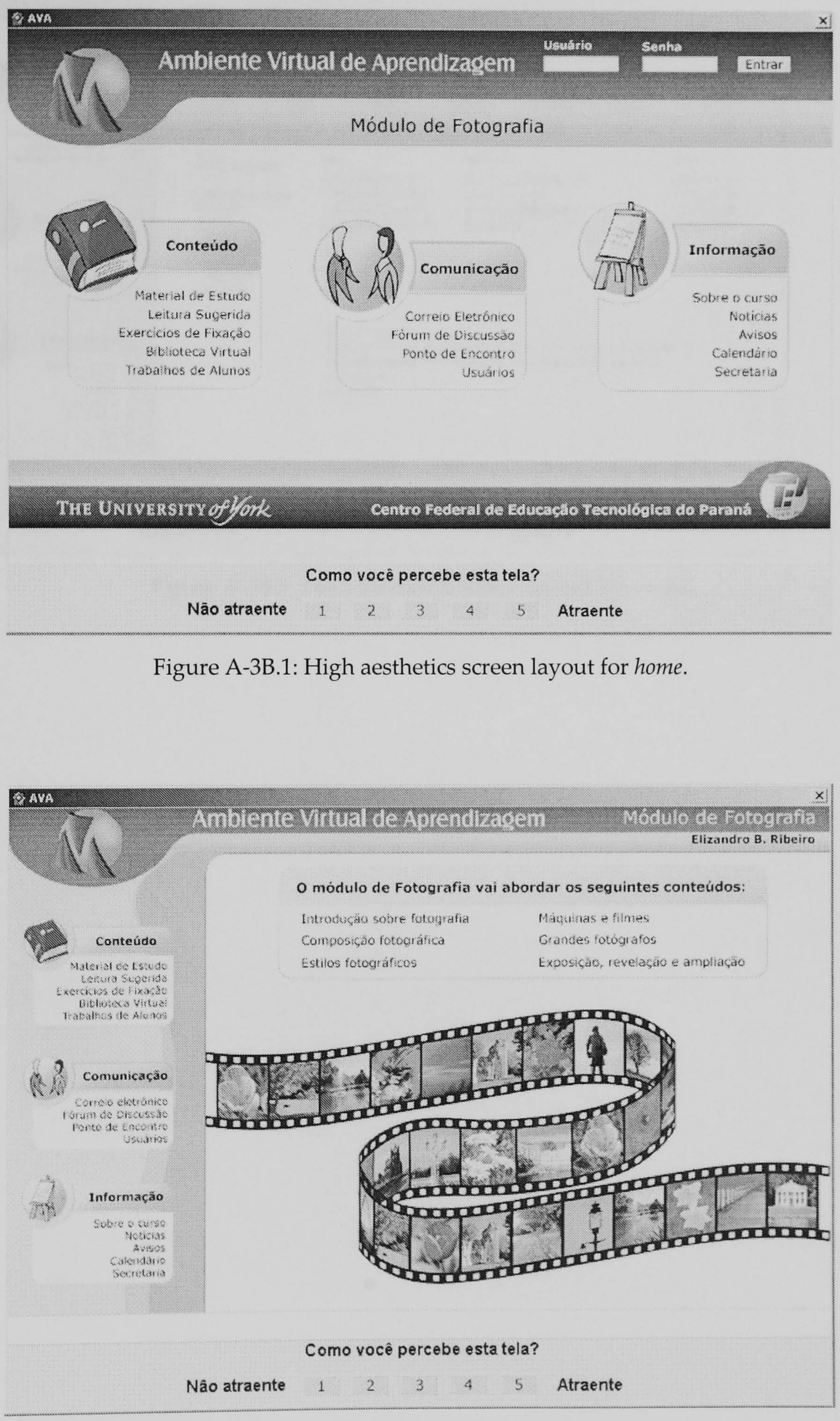


Figure A-3B.1: High aesthetics screen layout for *home*.

Figure A-3B.2: High aesthetics screen layout for *material*.

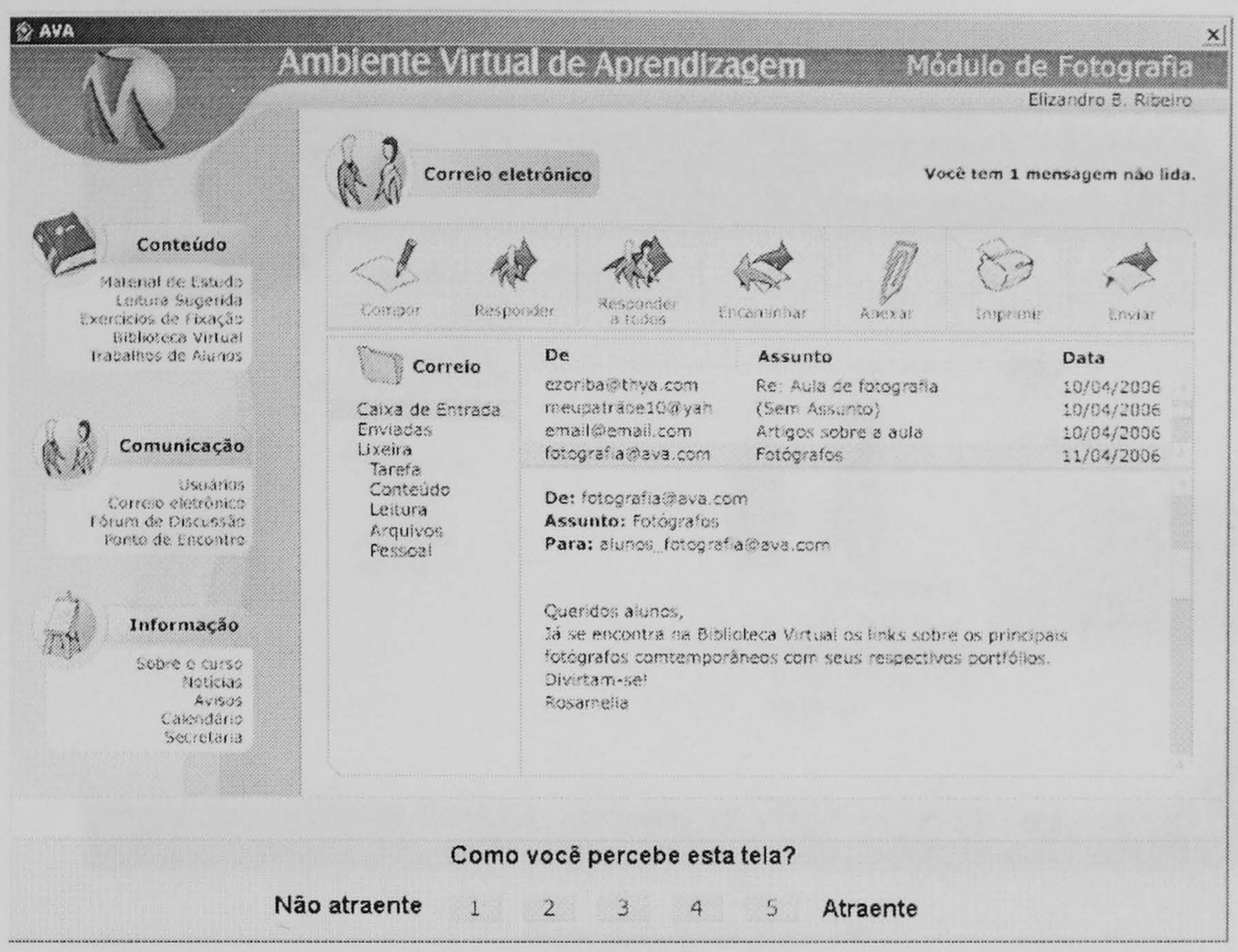


Figure A-3B.3: High aesthetics screen layout for *e-mail*.

Screen layouts used on the *low aesthetics* condition

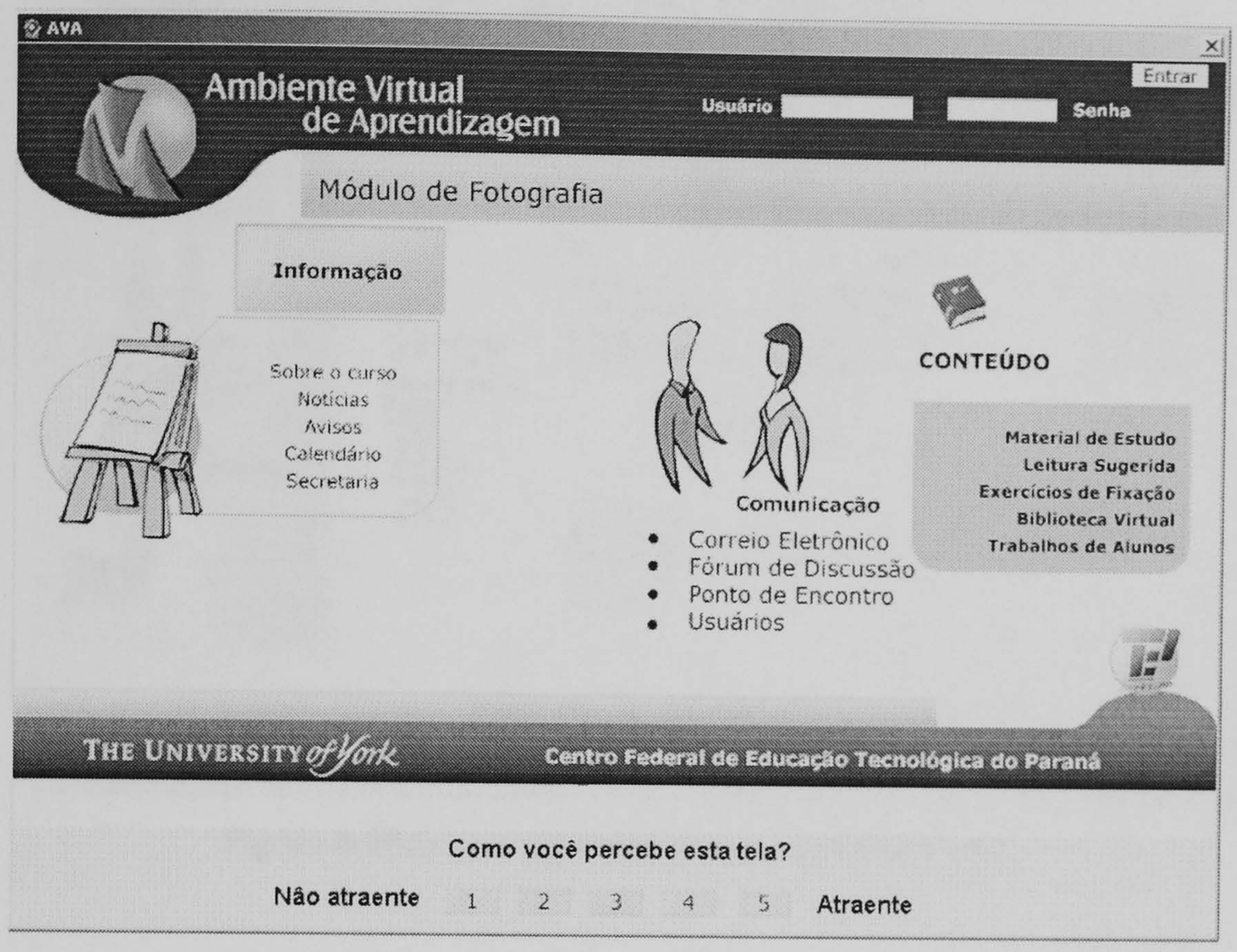


Figure A-3B.4: Low aesthetics screen layout for *home*.

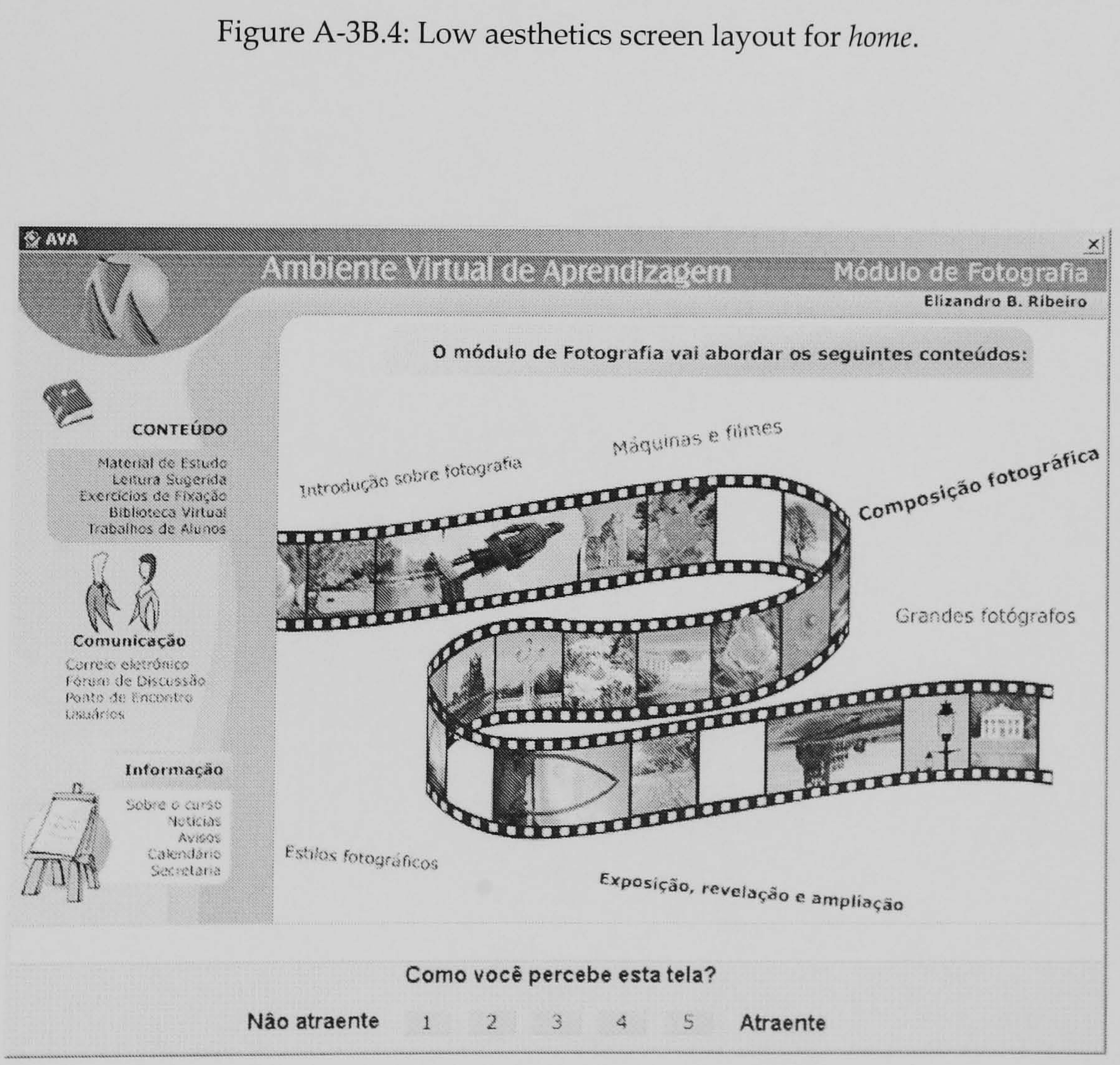


Figure A-3B.5: Low aesthetics screen layout for *material*.

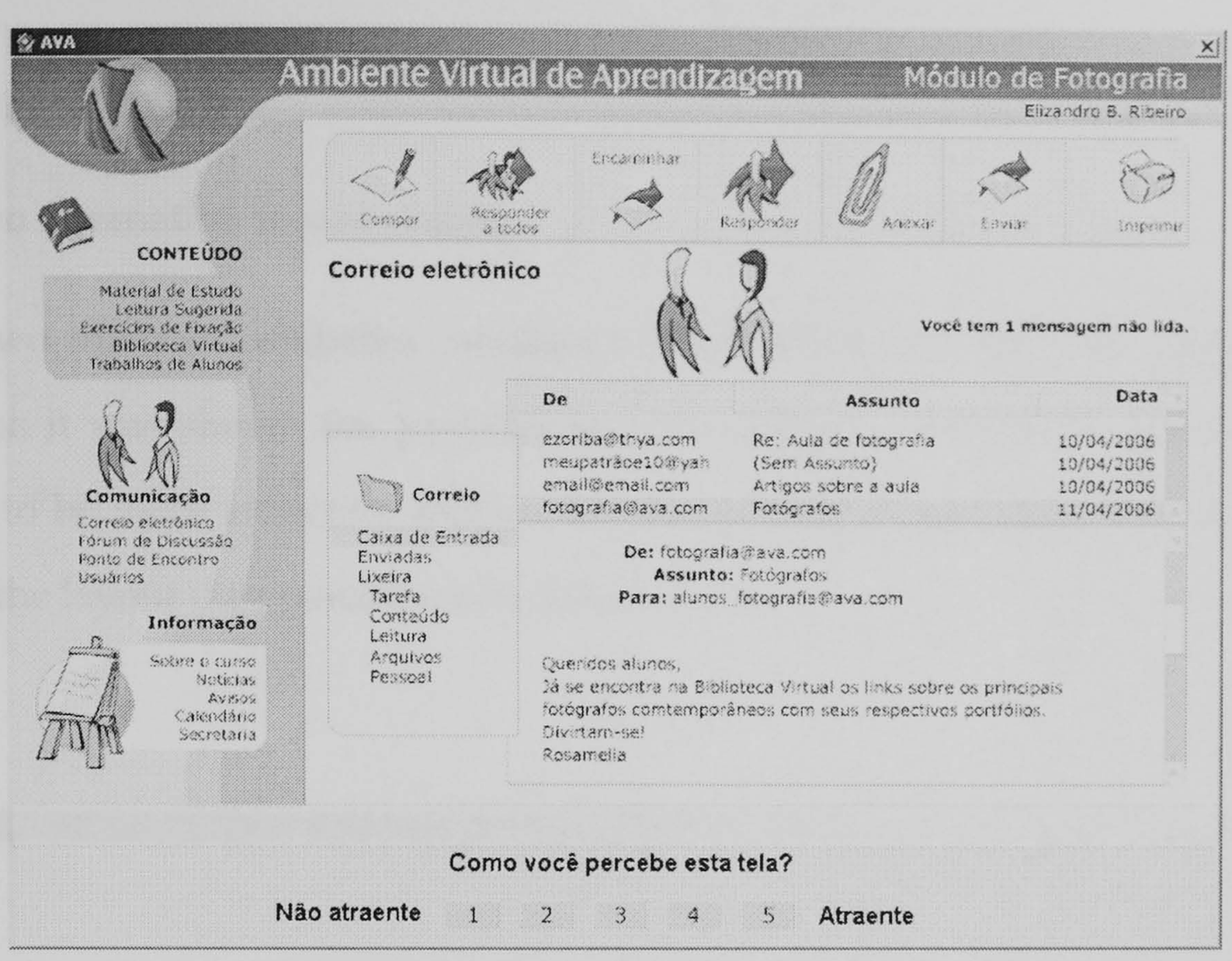


Figure A-3B.5: Low aesthetics screen layout for *e-mail*.

3 APPENDIX 2D

3.1 Two alternative forced-choice.

These two different aesthetics conditions where shown on the same page. The first time it was shown the participants were asked to choose the layout they believe to be more attractive and on the second time it was show they have to choose the layout they perceive to be easier to use.

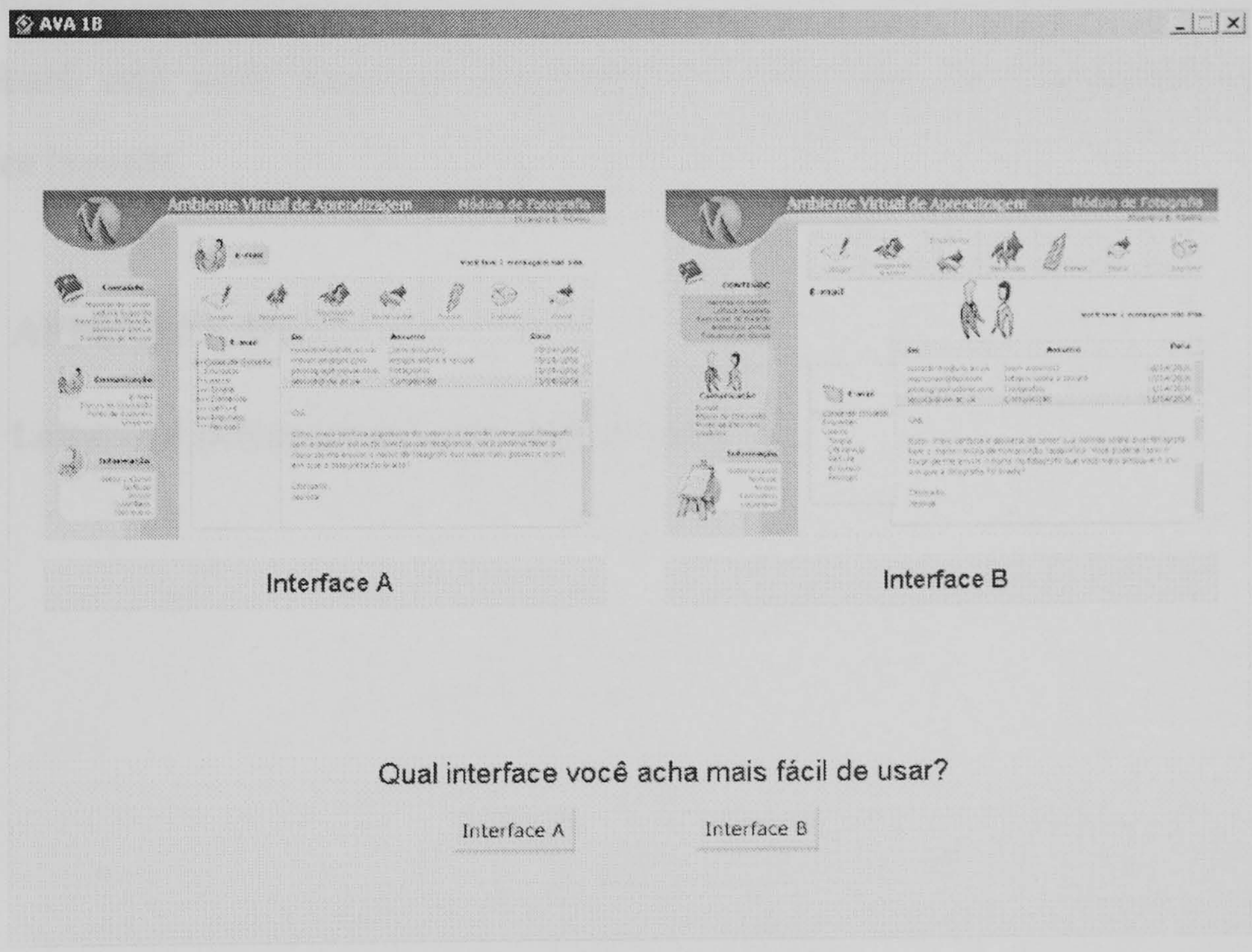


Figure A-3D.1: Figure showing the two alternative forced-choice.

Appendix 4

Material for experiment 3

This appendix illustrated the screen layouts used in experiment 3. Appendix 4A presents the letters of information and consent forms. Appendix 4B presents an example of the screen layouts used for the *high aesthetics, low aesthetics* condition, feedback and error message. Appendix 4C shows the two alternative forced-choice layouts.

1 APPENDIX 4A

1.1 Letters of information and consent forms

Aesthetics and Usability of Virtual Learning Environments

Letter of Information for the Participants

CEFET-PR is participating in a research project called 'Aesthetics and Usability of Virtual Learning Environments'. It intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

As part of this research, we will ask you to complete a task using the proposed Virtual Learning Environment and answer some questions about them using a rating scale. The questions intend to collect information about your perception of aesthetics and usability. This should not involve any risk or inconvenience to you.

All participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. All the data collected will be stored and used only for the purpose of the research. The data will also be anonymous and the only people who will have access to it will be the researcher and the Research Committee Members.

Any questions about the research may be addressed to:

Rosamelia Parizotto Ribeiro

Department of Psychology	LaMid – Laboratório de Mídias do CEFET-PR
University of York – Heslington	Av. 7 de Setembro, 3165
YO10 5DD – York	80.230-901 - Curitiba
Telephone: +44 (1904) 432.869	Telefone: 41 (XX) 310-4824
e-mail: R.Ribeiro@psych.york.ac.uk	e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-4A.1: Letter of information for the participants (in English).

Aesthetics and Usability of Virtual Learning Environments

Letter of information for the Institution

During a short period on 2004, students and staff of CEFET-PR will be participating in a research project called 'Aesthetics and Usability of Virtual Learning Environments'. It intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface and is undertaken experimental work to collect data in Brazil and in UK. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

As part of this research, we will ask you to complete a task using the proposed Virtual Learning Environment and answer some questions about them using a rating scale. The questions intend to collect information about their perception of aesthetics and usability. This should not involve any risk or inconvenience to them.

All participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. The data collected will be stored and used only for the purpose of the research. The data will also be anonymous and the only people who will have access to it will be the researcher and the Research Committee Members.

Any questions about the research may be addressed to:

Rosamelia Parizotto Ribeiro

Department of Psychology
University of York – Heslington
YO10 5DD – York
Telephone: +44 (1904) 432.869
e-mail: R.Ribeiro@psych.york.ac.uk

LaMid – Laboratório de Mídias do CEFET-PR
Av. 7 de Setembro, 3165
80.230-901 - Curitiba
Telefone: 41 (XX) 310-4824
e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-4A.2: Letter of information for the institution (in English)

Estética e Usabilidade de Ambientes Virtuais de Aprendizagem

Carta de Informação para os Participantes

O CEFET-PR está participando de uma pesquisa sobre 'Estética e Usabilidade de Ambientes Virtuais de Aprendizagem'. A pesquisa pretende investigar a relação entre a estética e a usabilidade percebida pelo usuário de interfaces computacionais usadas como Ambientes Virtuais de Aprendizagem. Esta segunda parte irá investigar a correlação entre a usabilidade e a estética após a interação com a interface proposta desenvolvida com base no uso ou não-uso dos princípios de *design*.

Como parte desta pesquisa, será pedido aos participantes realizar uma tarefa usando o Ambiente Virtual de Aprendizagem proposto e responder algumas perguntas sobre a interface usando uma escala de avaliação. As perguntas pretendem coletar informações sobre a percepção do participante sobre a estética e a usabilidade da interface. Isto não deverá envolver nenhum risco ou inconveniente ao partipante.

Toda participação é voluntária e reserva ao participante o direito se retirar em qualquer etapa do experimento. Todos os dados coletados serão cuidadosamente guardados e usados somente para propósitos desta pesquisa. Os dados também serão anônimos e as únicas pessoas com acesso a eles serão a pesquisadora e os membros do seu Comitê de Pesquisa.

Qualquer pergunta ou dúvida sobre a pesquisa pode ser feita diretamente a pesquisadora ou encaminhada para:

Rosamelia Parizotto Ribeiro

Department of Psychology
University of York – Heslington
YO10 5DD – York
Telephone: +44 (1904) 432.869
e-mail: R.Ribeiro@psych.york.ac.uk

LaMid – Laboratório de Mídias do CEFET-PR
Av. 7 de Setembro, 3165
80.230-901 - Curitiba
Telefone: 41 (XX) 310-4824
e-mail: R.Ribeiro@psych.york.ac.uk

Figure A-4A.3: Letter of information for the participants (in Portuguese)

THE UNIVERSITY *of York*

Consent from Participants

Investigator's name: Rosamelia Parizotto Ribeiro

Title of study: Aesthetics and Usability of Virtual Learning Environments.

Brief description of study: This research project intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

Declaration of consent

I have read the accompanying letter and I have been informed about the aims and procedures involved in the experiment in which I am about to participate. I understand that the participation is voluntary and I reserve the right to withdraw at any stage in the proceedings. Any information that I have provided as part of the study will be confidential and my identity removed unless I agree otherwise.

I agree to participate in this Research.

Printed name: _____

Signature: _____

Category: _____

e-mail address: _____

Date: _____

Figure A-4A.4: Consent from the participants (in English)

THE UNIVERSITY *of York*

Consent from the Head of the Educational Institution

Investigator's name: Rosamelia Parizotto Ribeiro

Title of study: Aesthetics and Usability of Virtual Learning Environments.

Brief description of study: This research project intends to investigate the relationship between users' perceived aesthetics and perceived usability of a Virtual Learning Environment interface. This second part will investigate the correlation of usability and aesthetics after the interaction with a proposed computer interface developed on the basis of using or not using of the design principles.

Declaration of consent

I have read the accompanying letter and I have been informed about the aims and procedures involved in the research project described above. I reserve the right to withdraw any participant at any stage in the proceedings. I understand that the information gained will be anonymous and that the participants' name will not be in any materials used in the research, unless the participants agree otherwise.

I agree that the students and staff of this Educational Institution participate in this Research.

Printed name: _____

Role: _____

Signature: _____

e-mail address: _____

Date: _____

Figure A-4A.5: Consent from the head of the educational institution (in English)

2 APPENDIX 4B

2.1 Two aesthetics conditions

This appendix presents the screen layouts used for the *low* and *high aesthetics* condition. There is an example from each *set of pages* used to develop the prototype. Also there are screen layouts showing feedback and error message.

Screen layouts used for the *high aesthetic* condition

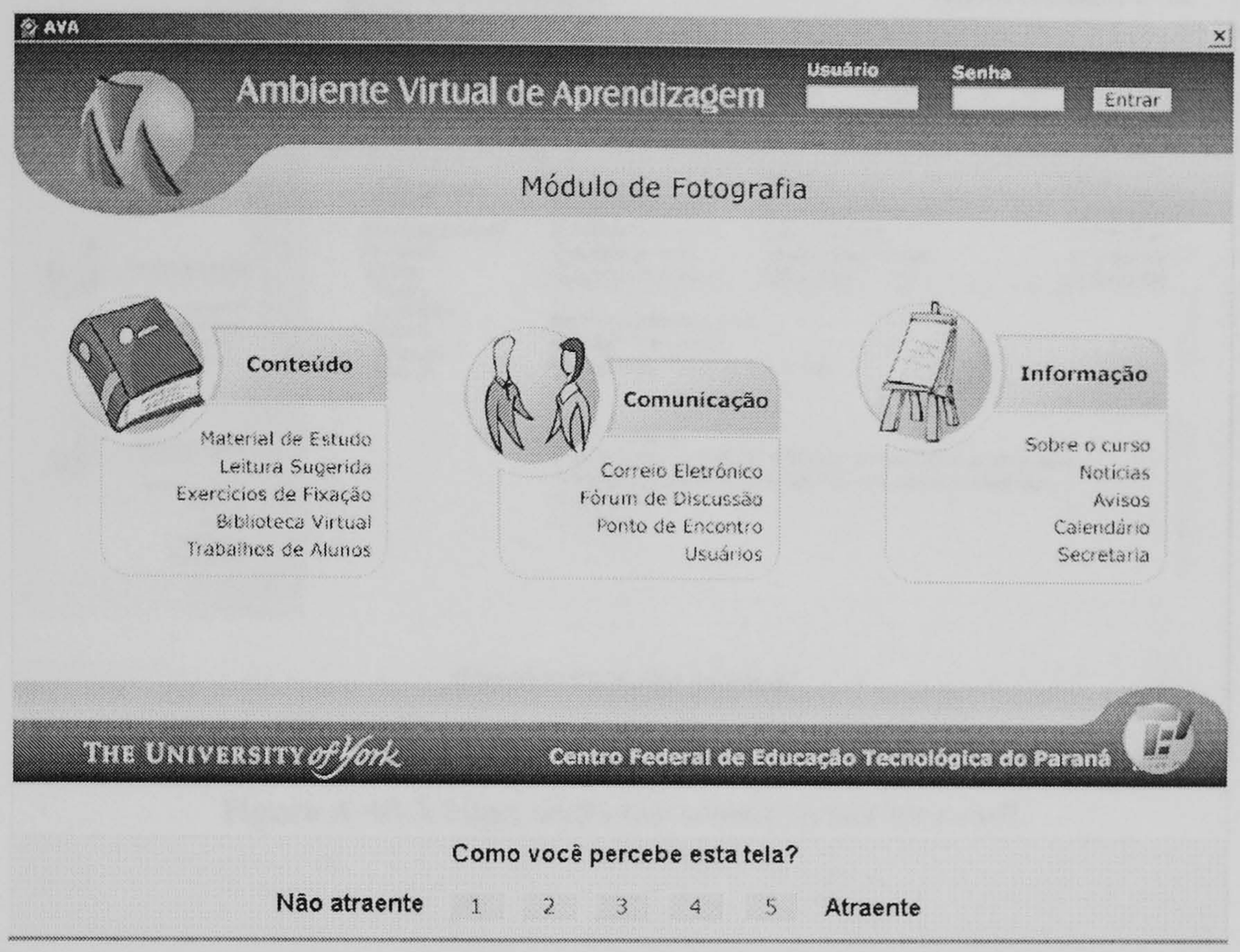


Figure A-4B.1: High aesthetics screen layout for *home*.

Figure A-4B.2: High aesthetics screen layout for *material*.

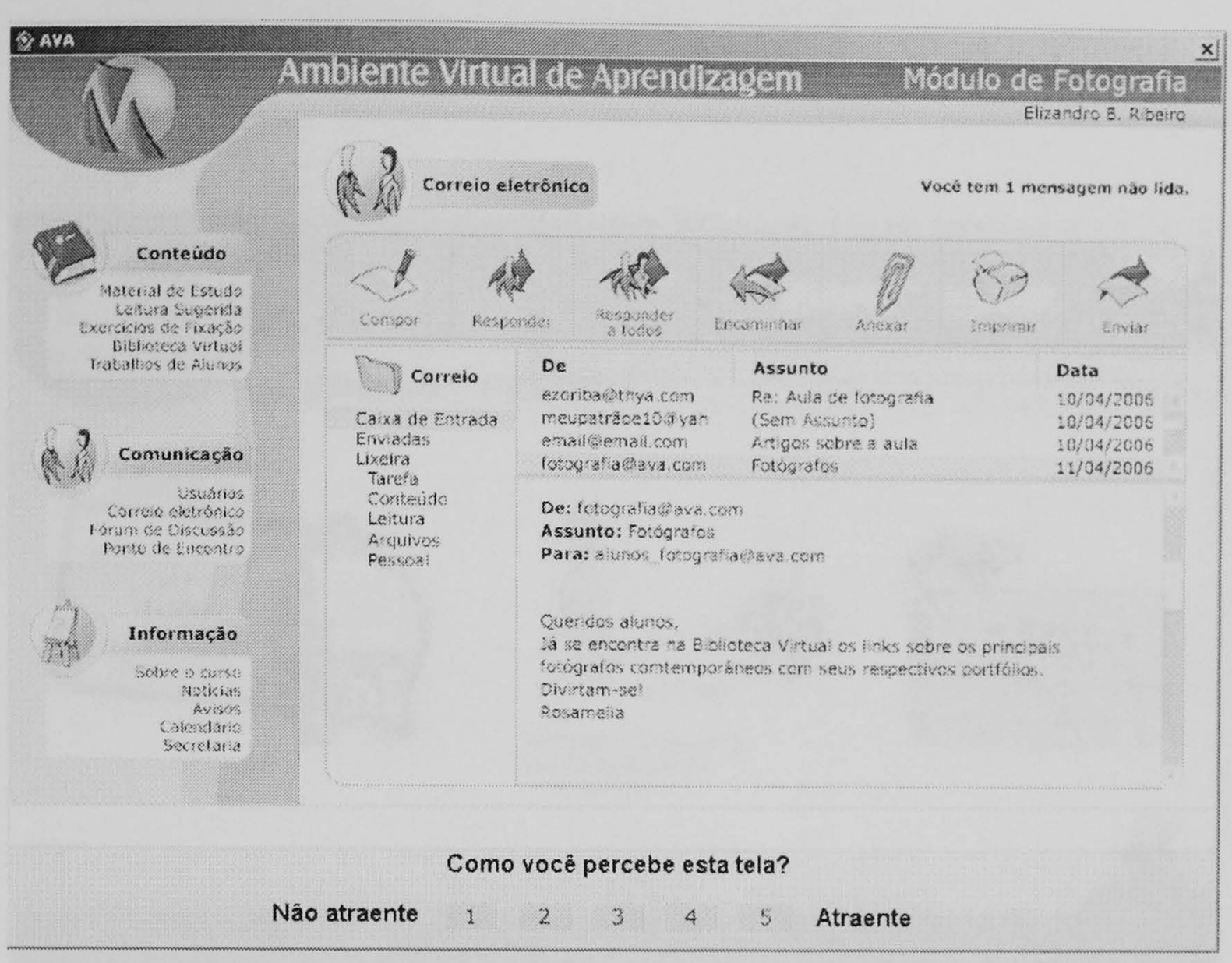


Figure A-4B.3: High aesthetics screen layout for *e-mail*.

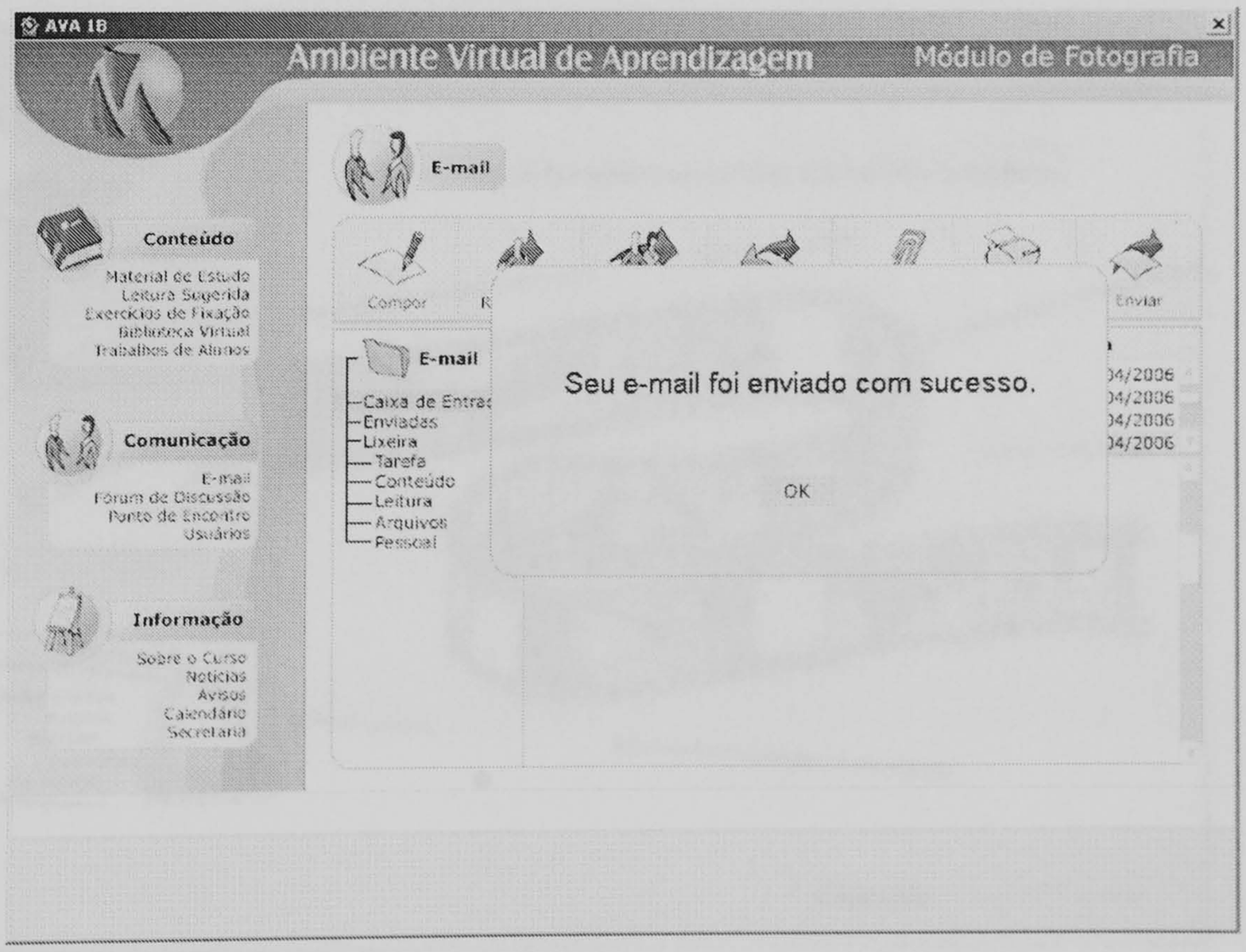


Figure A-4B.4: Screen layout showing a feedback message.

Screen layouts used on the *low aesthetics* condition

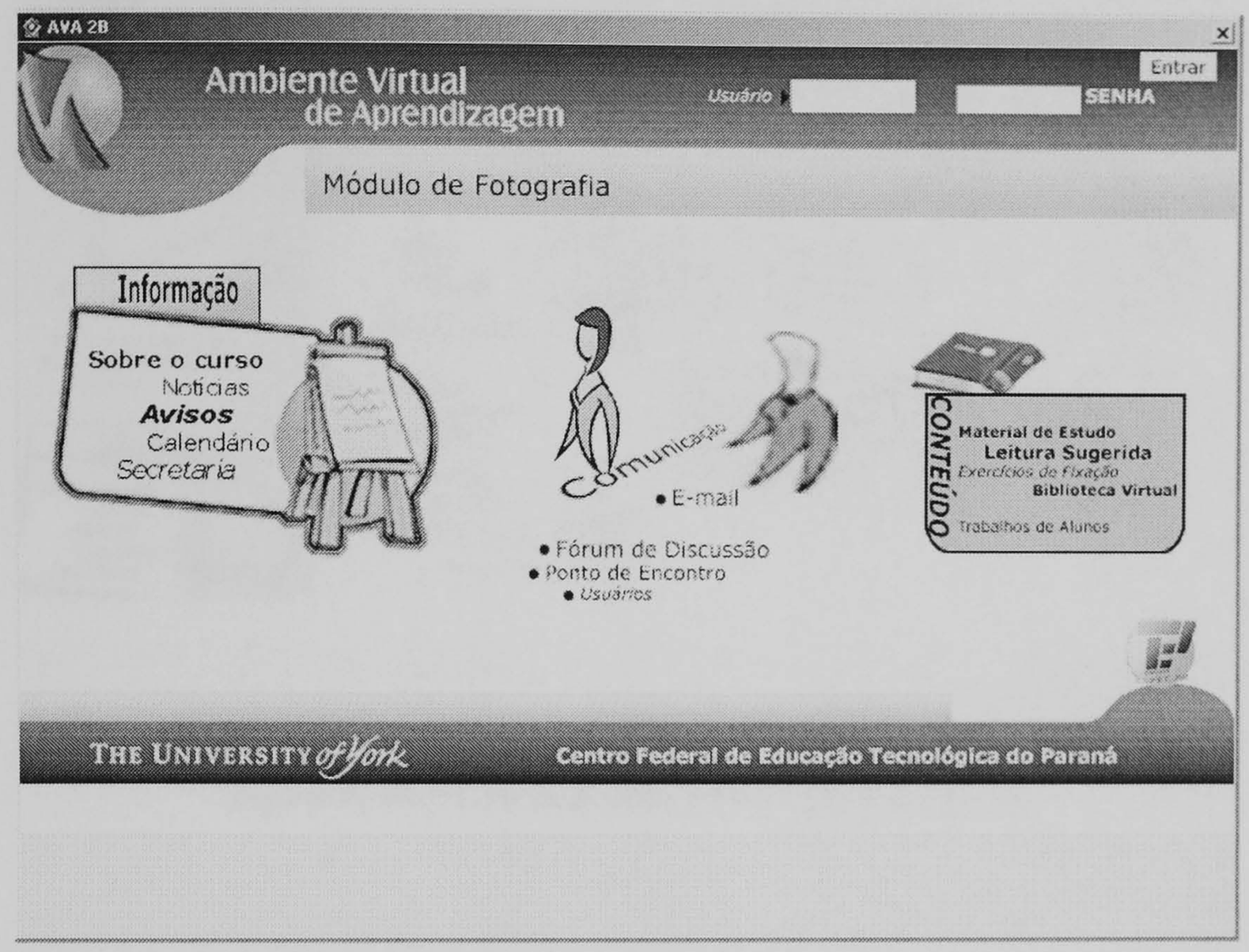


Figure A-4B.5: Low aesthetics screen layout for *home*.

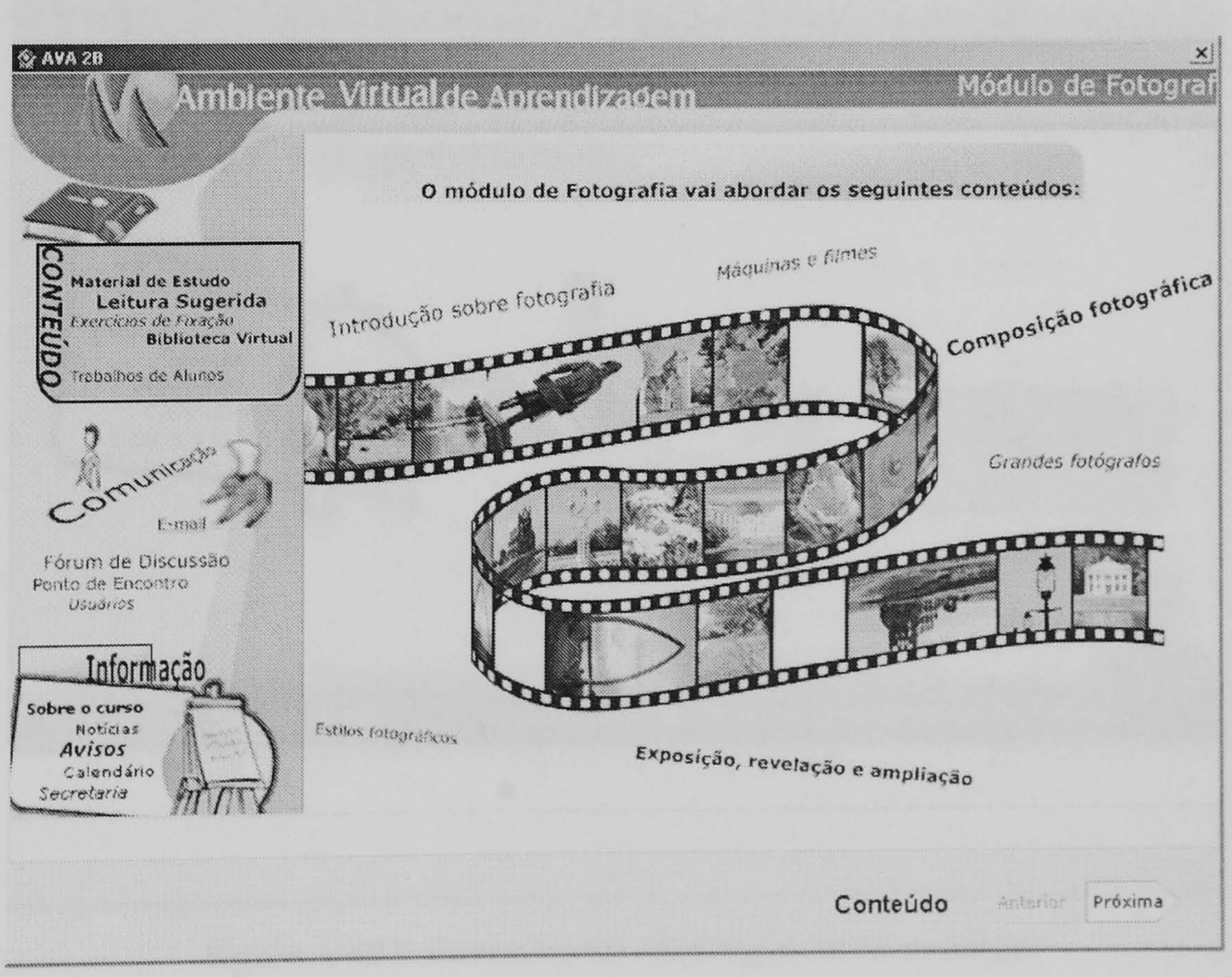


Figure A-4B.6: Low aesthetics screen layout for *material*.

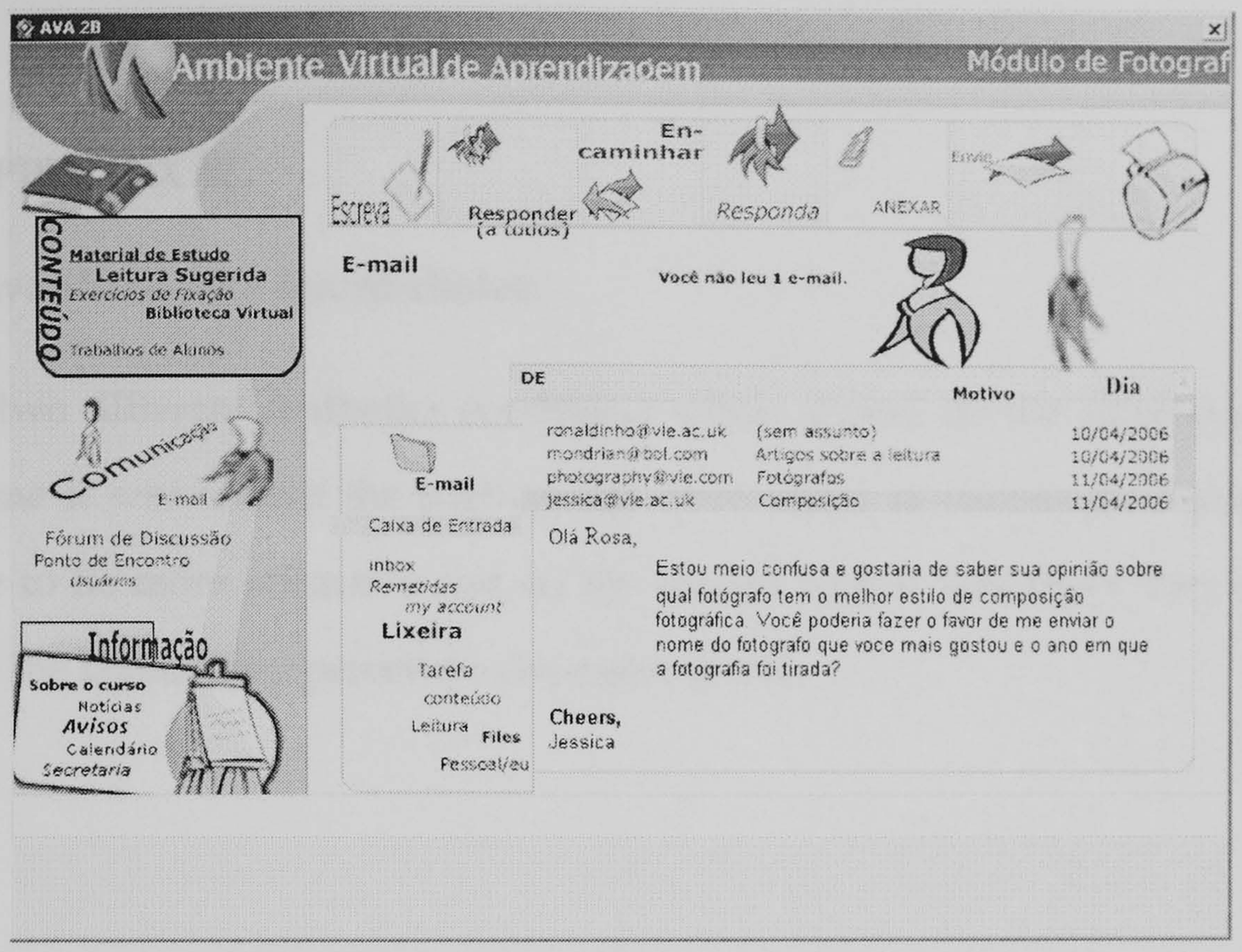


Figure A-4B.7: Low aesthetics screen layout for *e-mail*.

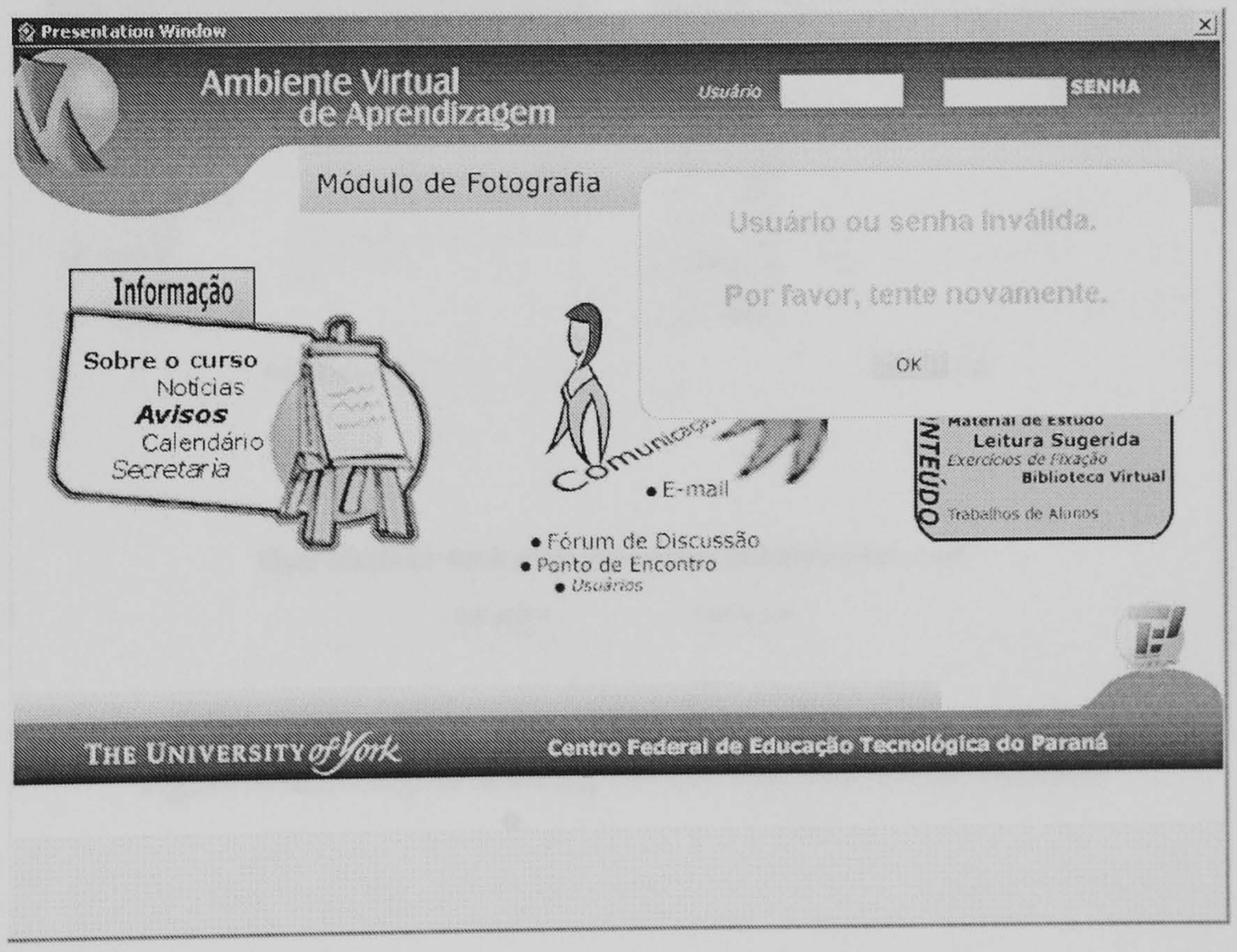


Figure A-4B.8: Screen layout showing an error message.

3 APPENDIX 4C

3.1 Two alternative forced-choice.

These two different aesthetics conditions where shown on the same page. The first time it was shown the participants were asked to choose the layout they believe to be more attractive and on the second time it was show they have to choose the layout they perceive to be easier to use.

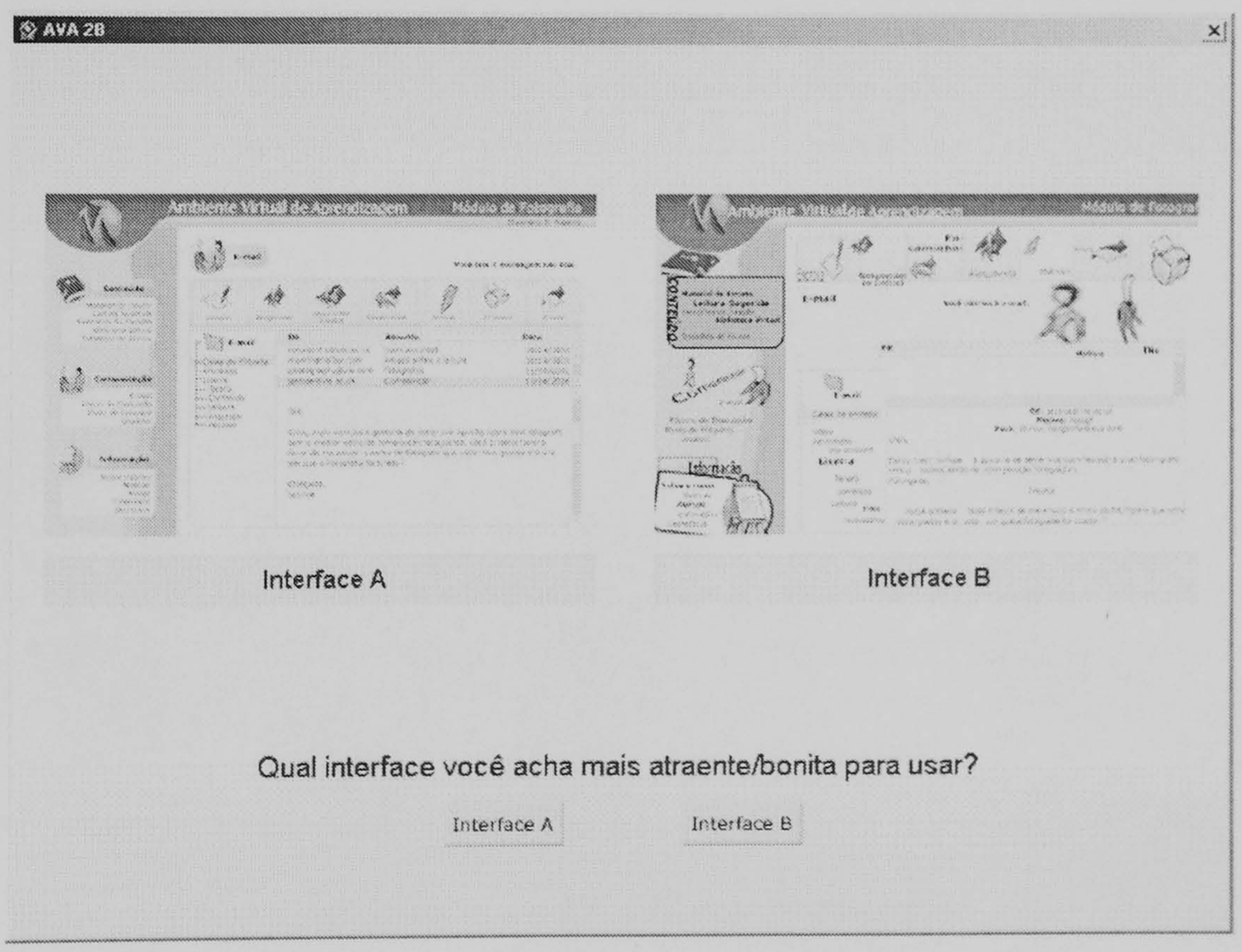
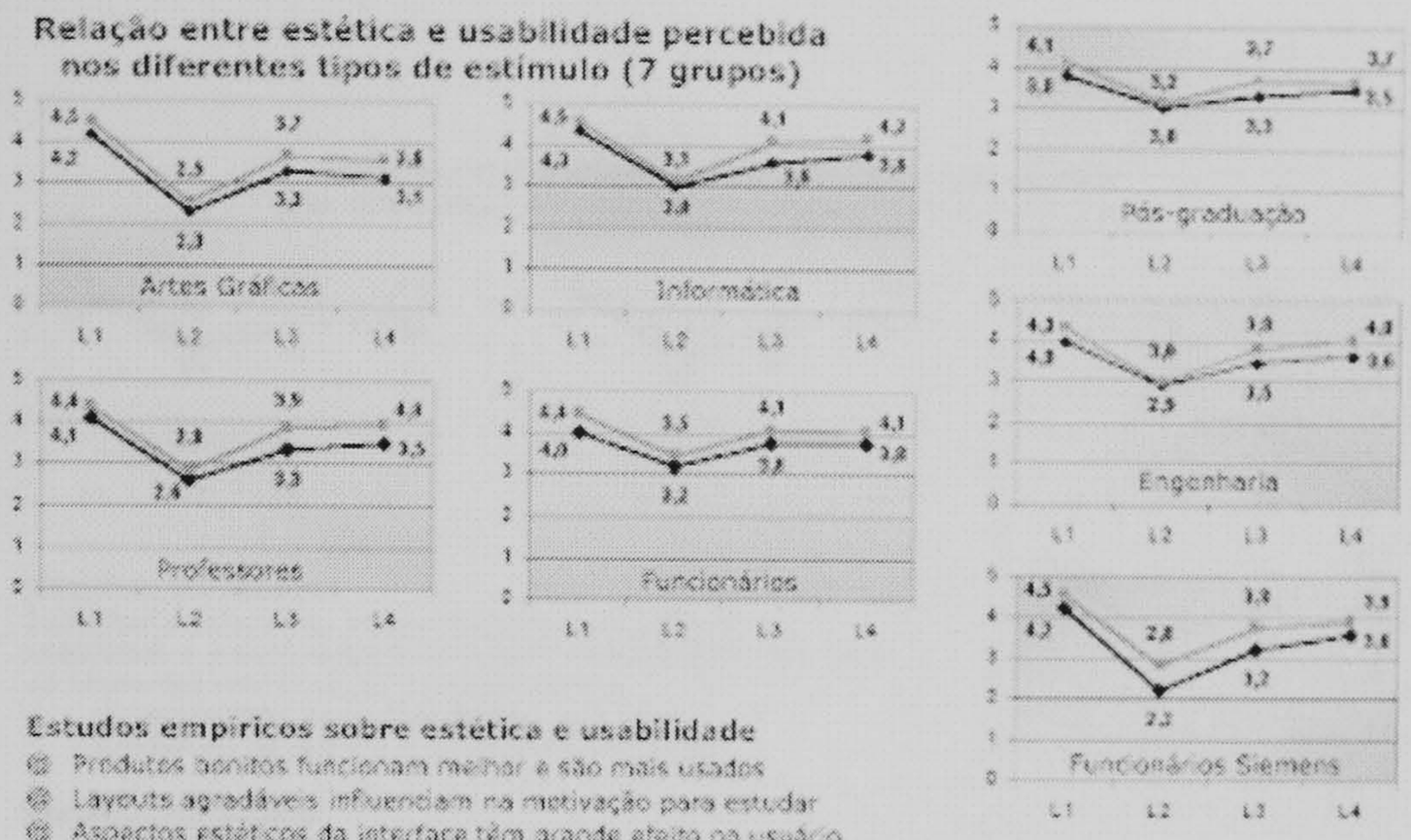


Figure A-4C.1: Figure showing the two alternative forced-choice.

Appendix 5

Flyer

This Appendix presents the flyer used to give feedback showing the main results form experiment 1.



Estudos empíricos sobre estética e usabilidade

- Produtos bonitos funcionam melhor e são mais usados
- Layouts agradáveis influenciam na motivação para estudar
- Aspectos estéticos da interface têm grande efeito no usuário
- Estética está correlacionada com a usabilidade percebida do sistema, antes e após o seu uso

Resultados e conclusões

A análise dos dados obtidos com o uso de telas estáticas revelou que as variáveis, estética e usabilidade percebida, apresentam uma correlação positiva nas 4 diferentes condições de layout.

A variação do tipo de estímulo e os diferentes layouts se revelou significante.
Isto sugere que a percepção da estética e sua influência sobre a usabilidade percebida depende do do uso dos princípios de design (unidade, proporção, homogeneidade, equilíbrio e ritmo) para elaborar os diferentes layouts (L1, L2, L3, L4) mas independe do tipo de estímulo (home, material, e-mail).

A diferença entre os 7 grupos não foi significante indicando que neste nível de design a percepção da estética independe do gênero, idade, escolaridade e diferenças individuais.

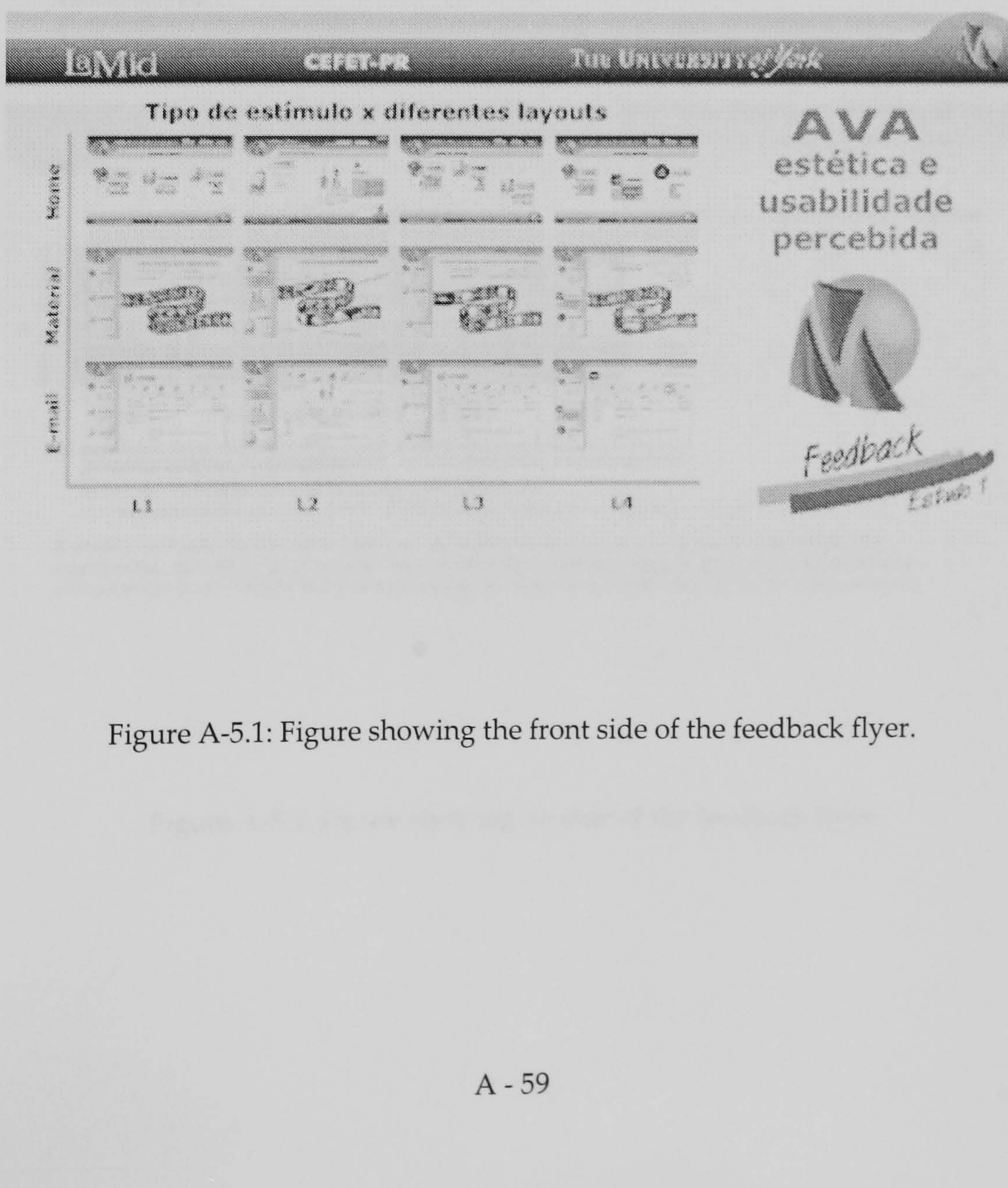


Figure A-5.1: Figure showing the front side of the feedback flyer.

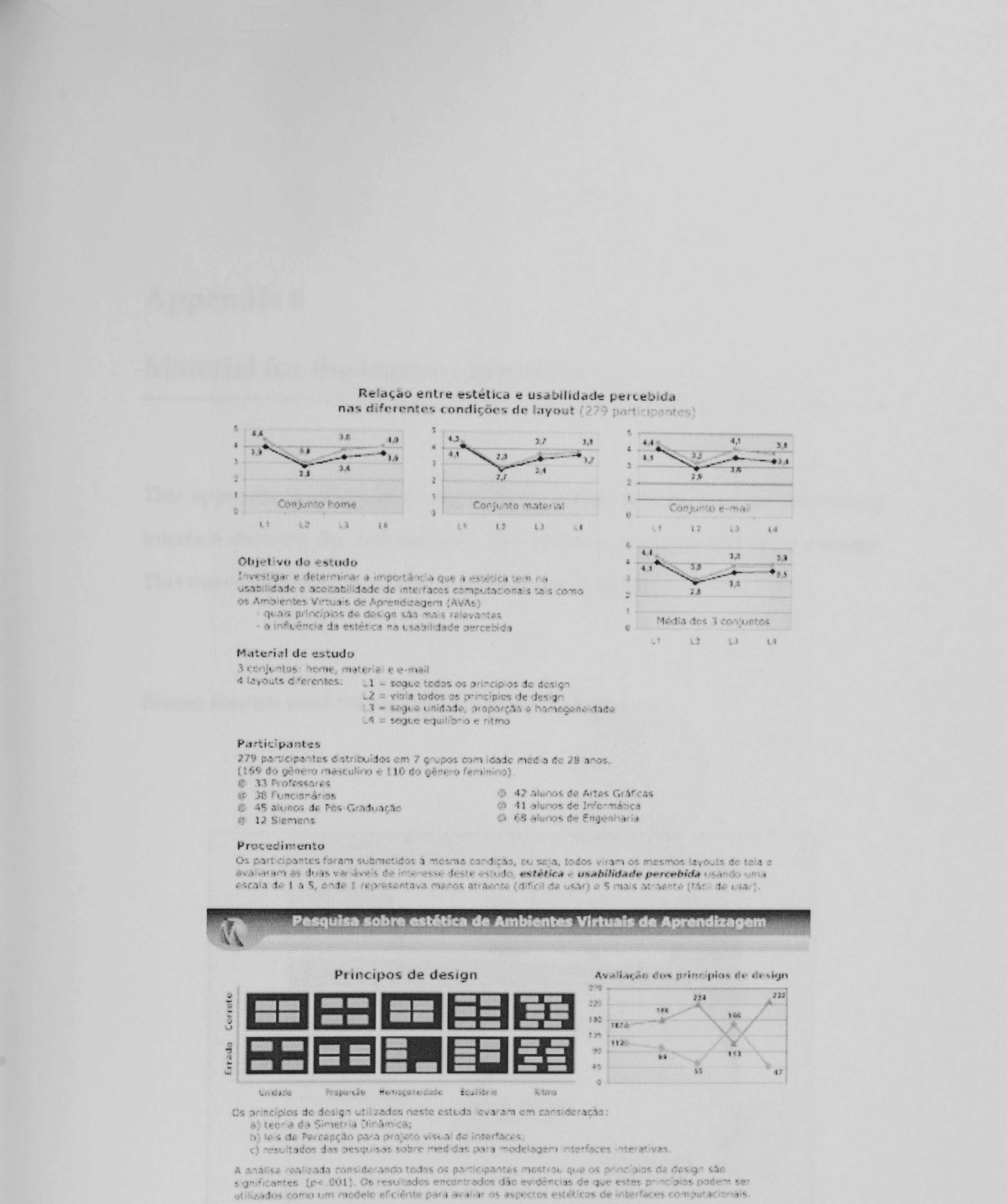


Figure A-5.1: Figure showing on side of the feedback flyer.

Appendix 6

Material for the *training* interface

This appendix presents an example of the screen layouts used on the *training* interface showing the *high aesthetics, low aesthetics* condition and error message. This *training* interface was used in experiments 3 and 4.

Screen layouts used for the *high aesthetic* condition

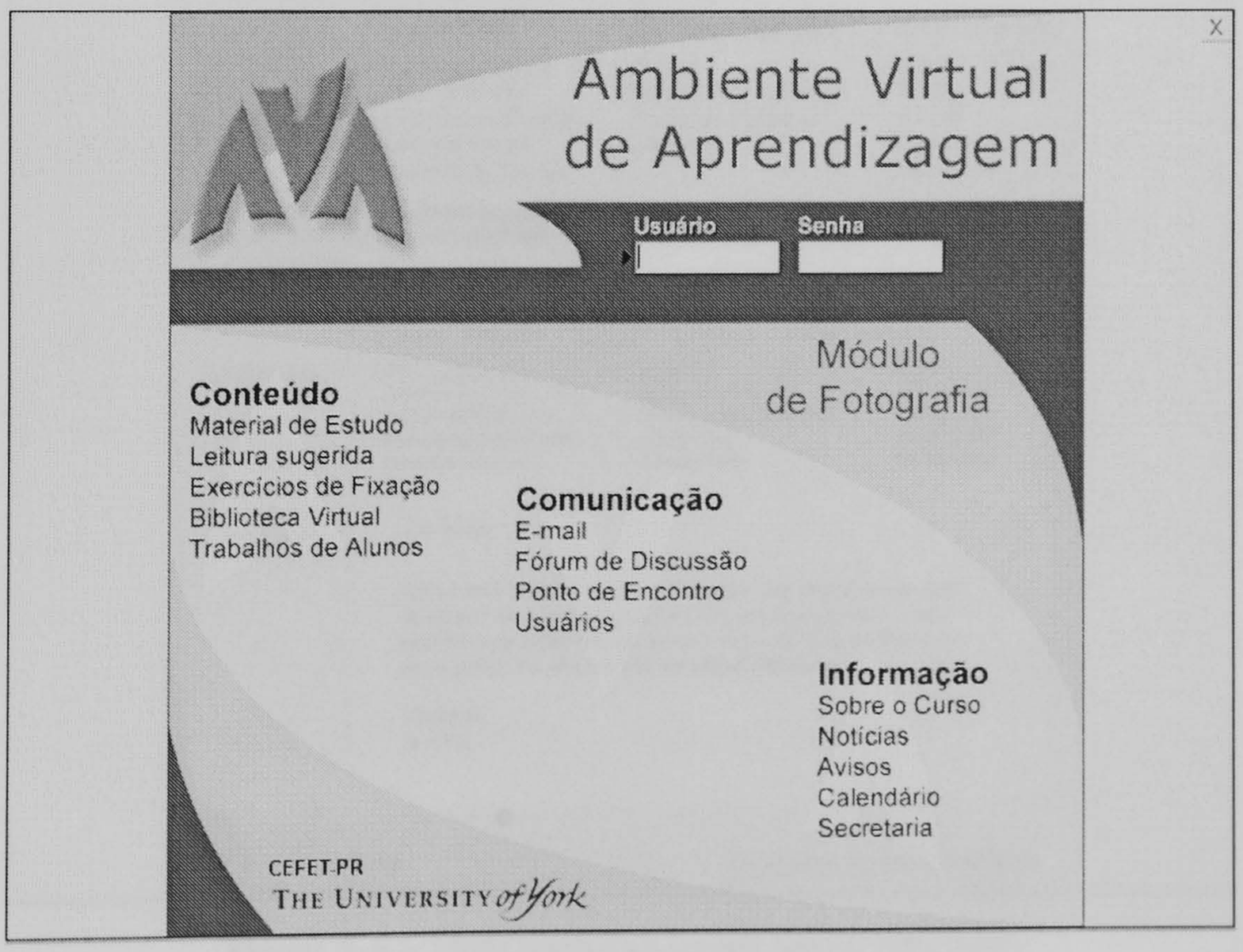


Figure A-6.1: High aesthetics screen layout for *home*.

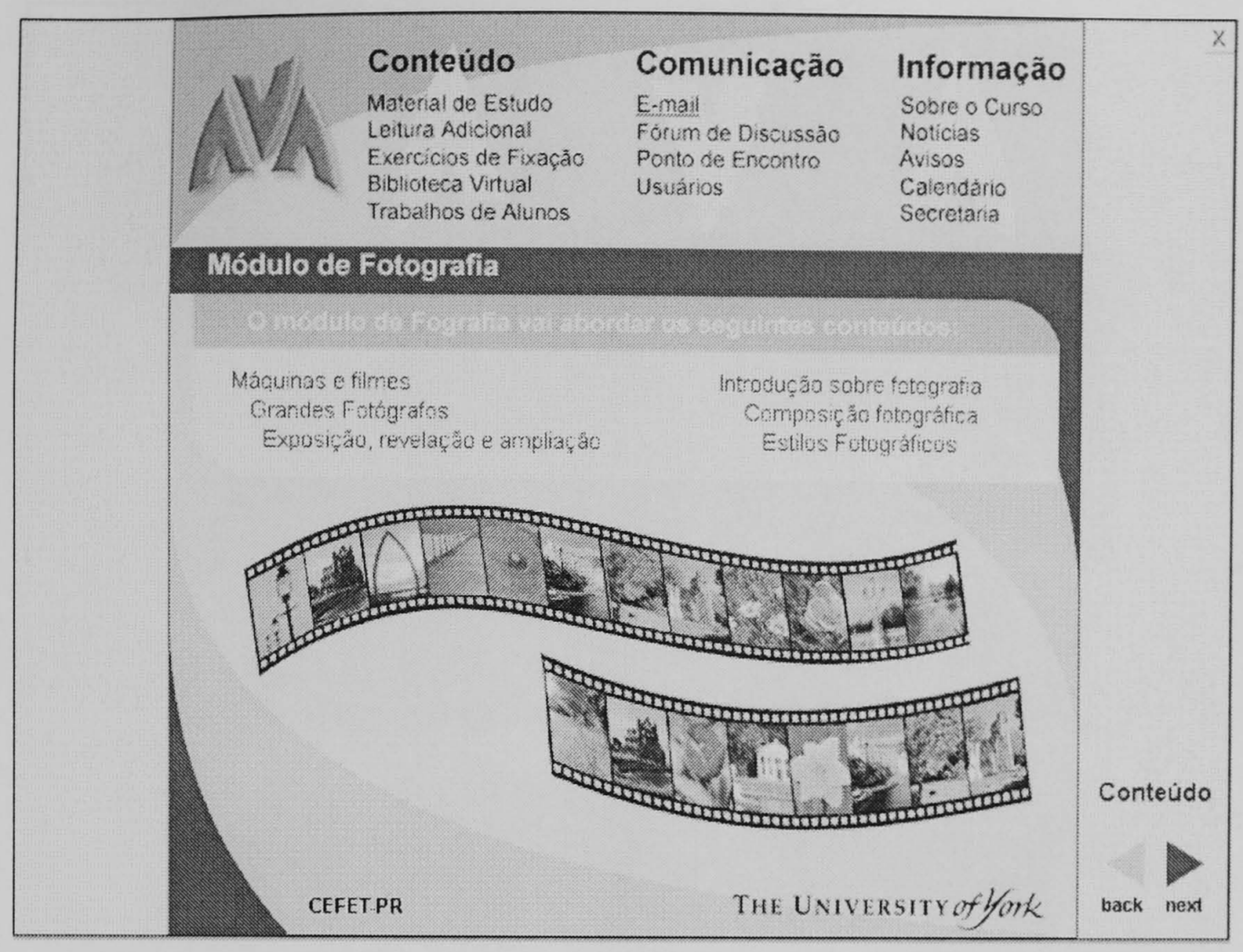


Figure A-6.2: High aesthetics screen layout for *material*.

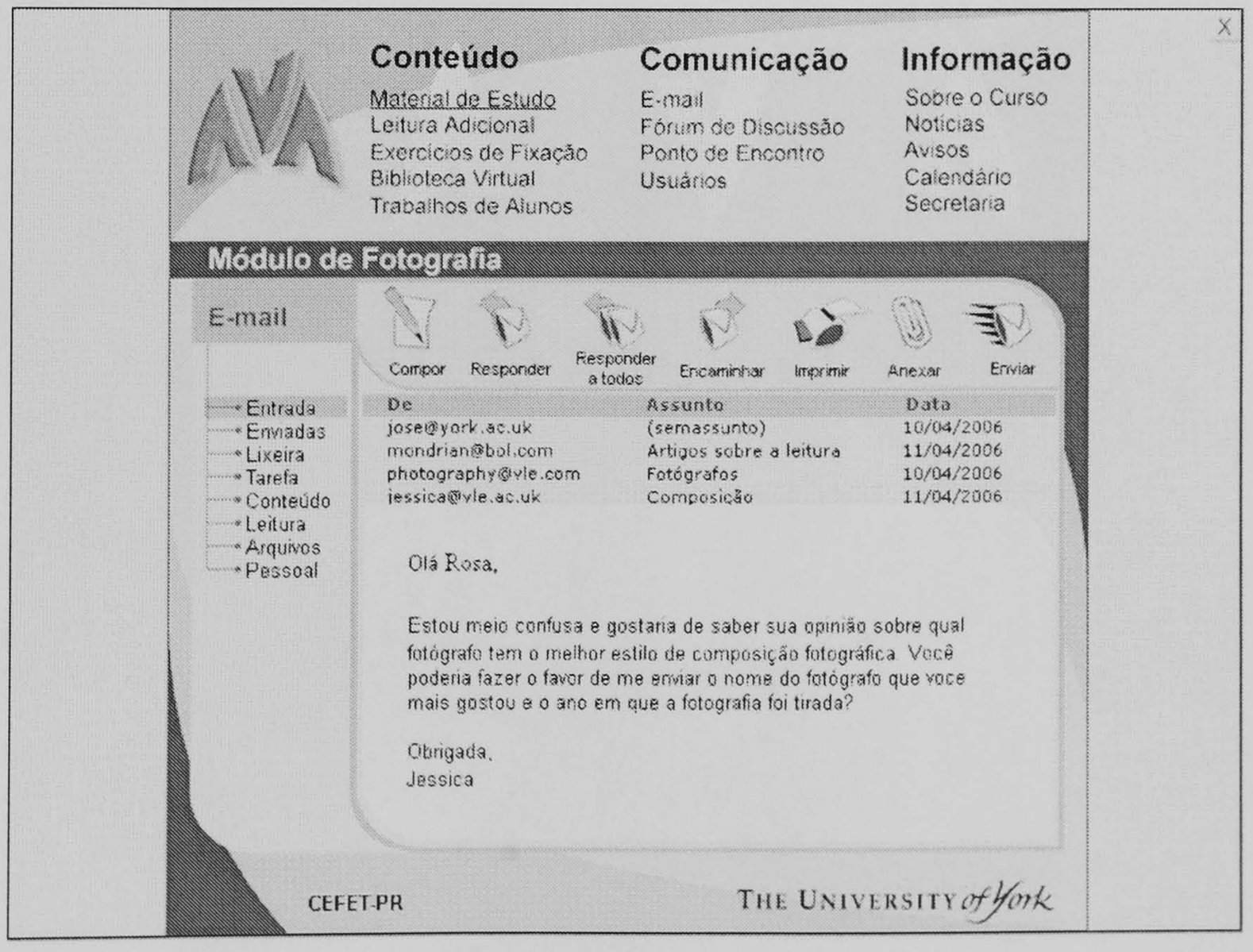


Figure A-6.3: High aesthetics screen layout for *e-mail*.

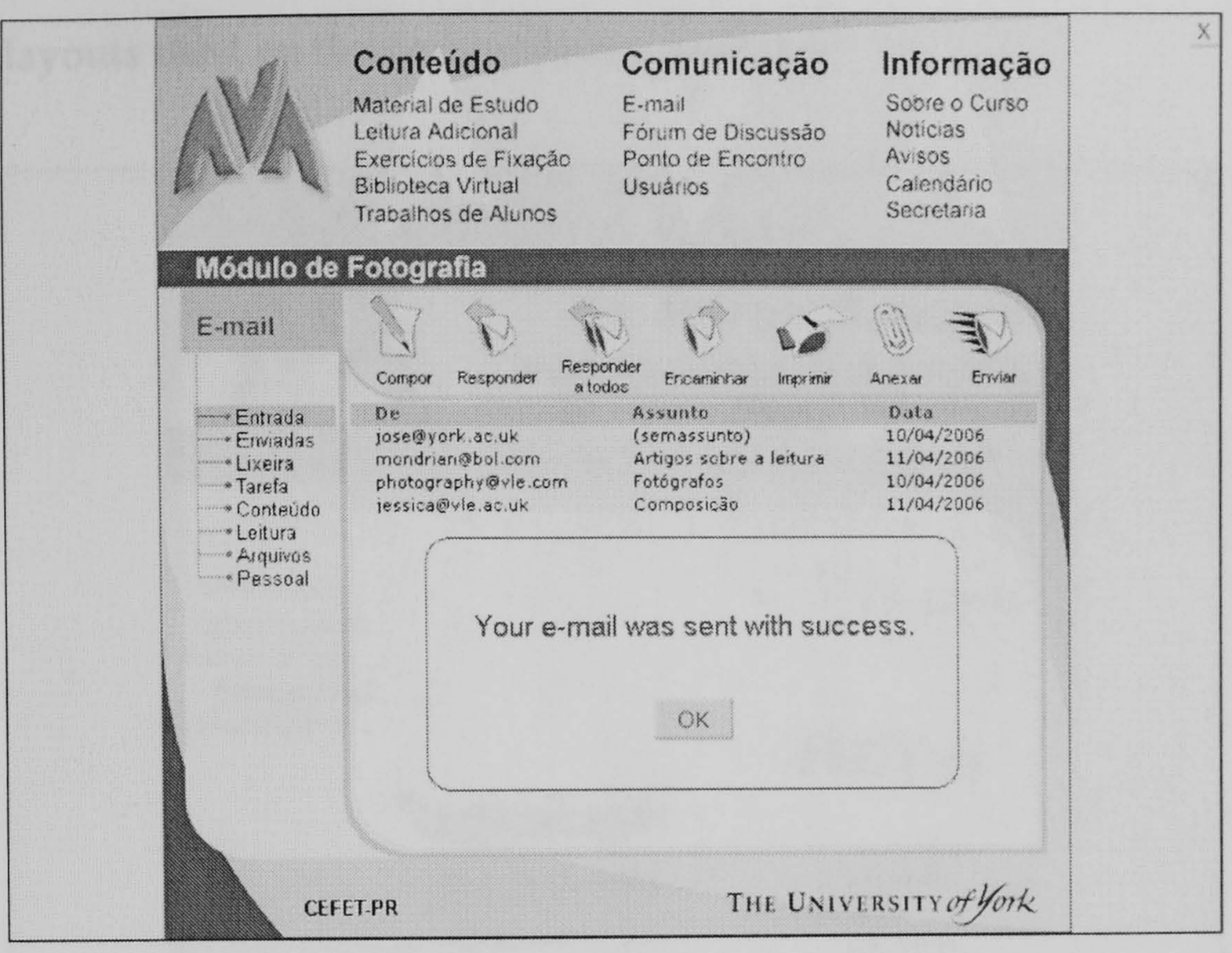


Figure A-6.4: High aesthetics screen layout showing a feedback message.

Screen layouts used on the *low aesthetics* condition

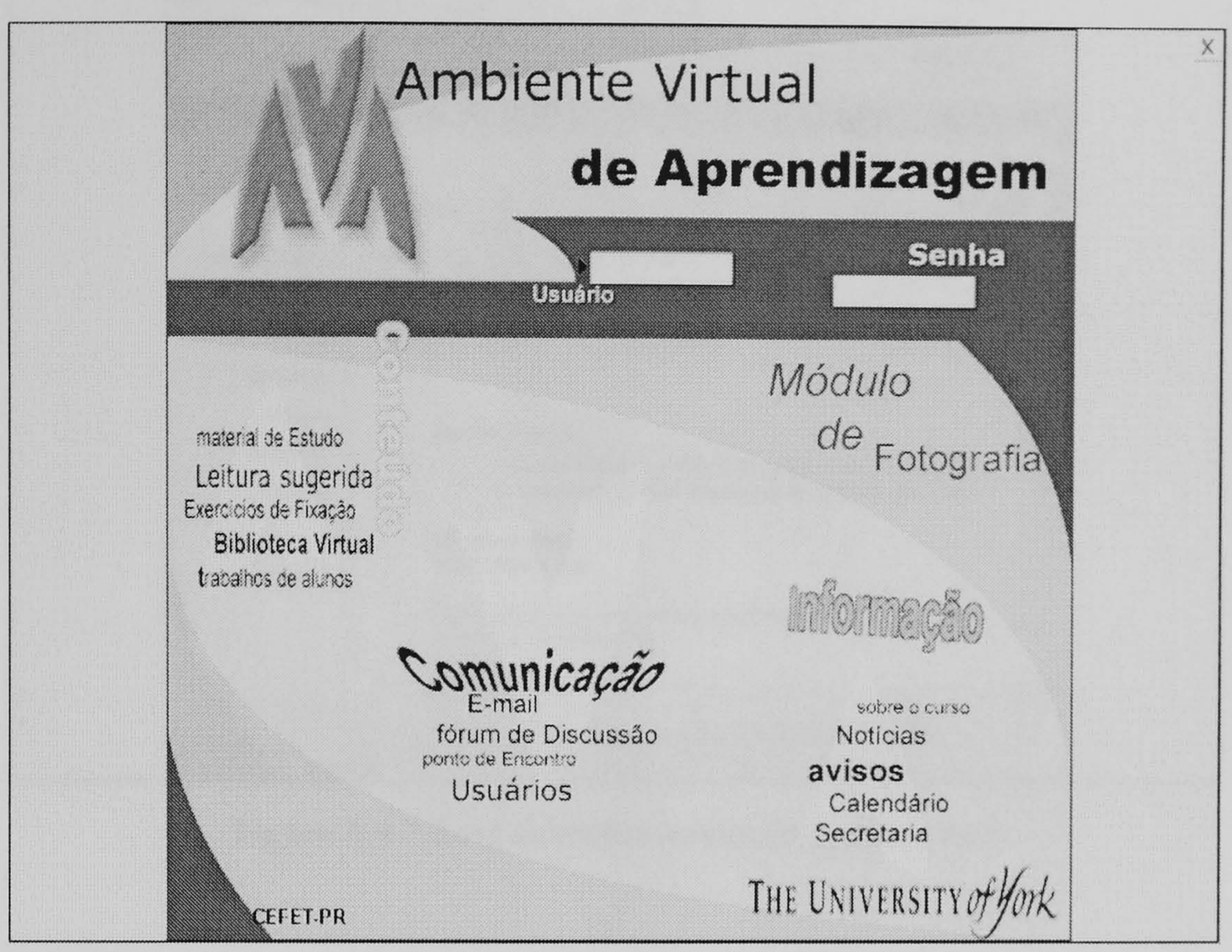


Figure A-6.5: Low aesthetics screen layout for *home*.

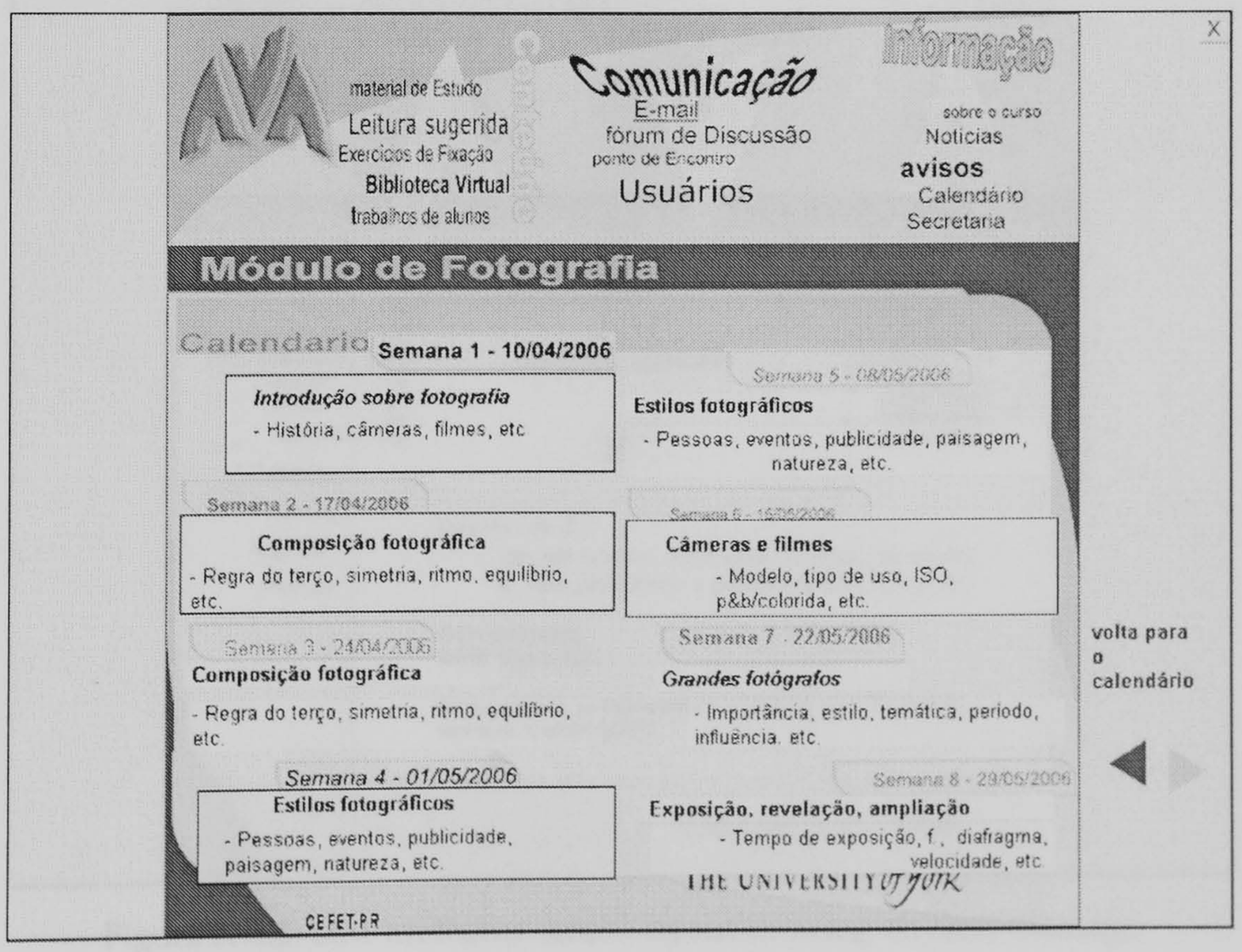


Figure A-6.6: Low aesthetics screen layout for *material*.

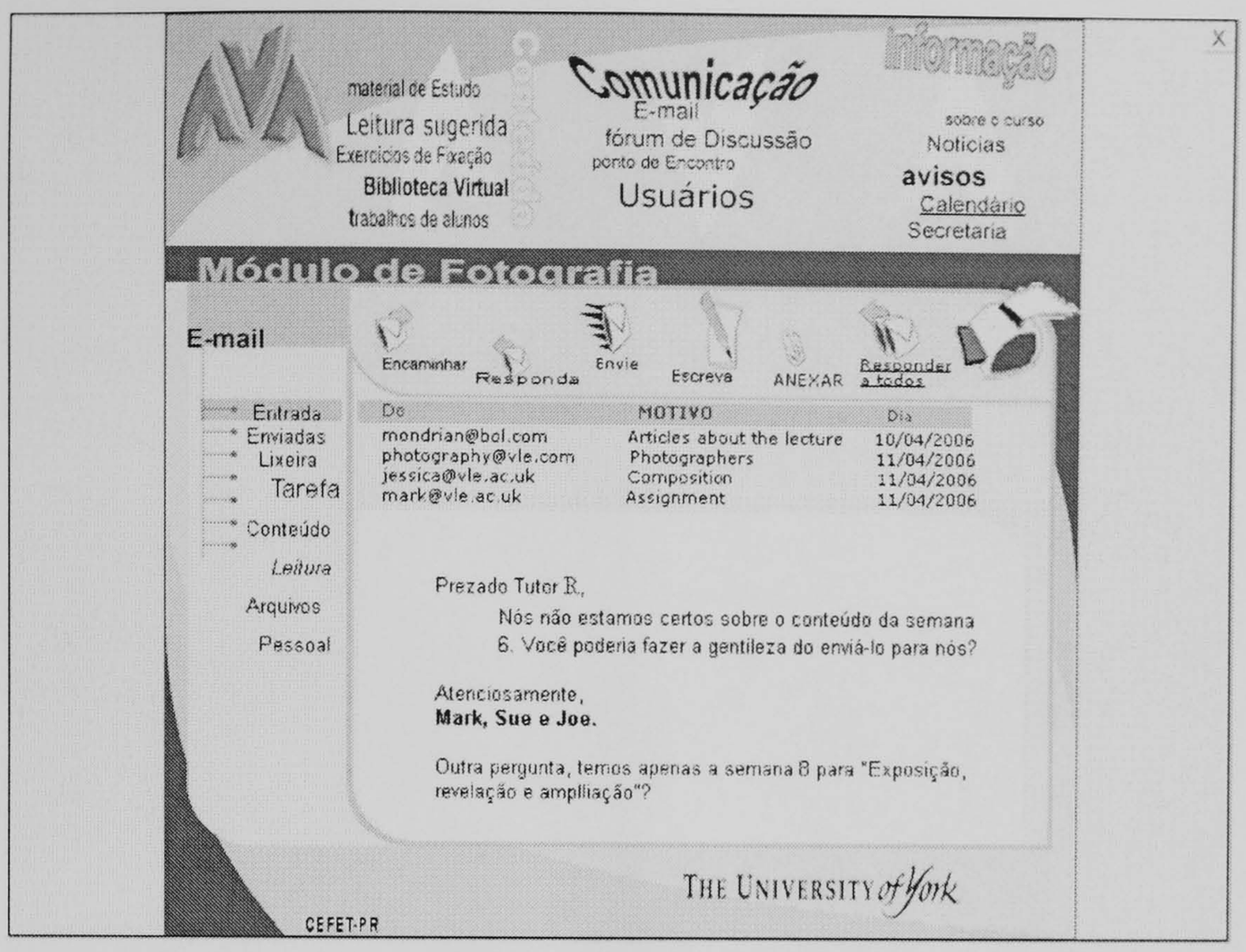


Figure A-6.7: Low aesthetics screen layout for *e-mail*.

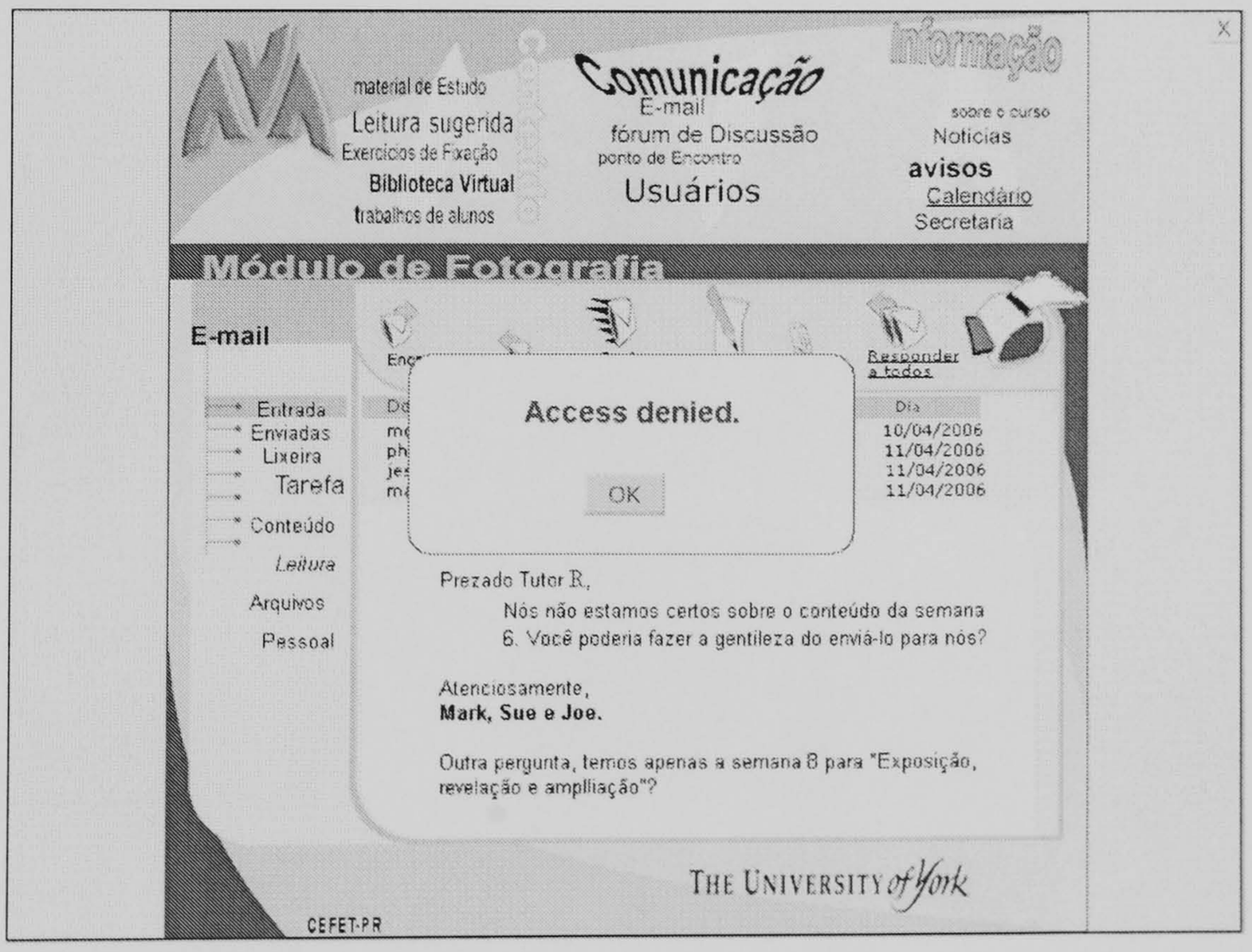


Figure A-6.8: Low aesthetics screen layout showing an error message.