

2023

**ANA GLÓRIA BARÃO
DOS SANTOS NEVES**

**BASIC DESIGN INNOVATION WITH
THE CONTRIBUTION OF VIRTUAL
REALITY-BASED TOOLS: APPENDIX**

Tese apresentada ao IADE - Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia, para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Design, realizada sob a orientação científica da Doutora Maria Emília Capucho Duarte, Professora Catedrática da Universidade Europeia e da Doutora Diana da Silva Dias, Professora Catedrática da Universidade Lusófona.

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Appendix

A. Informed consent (pilot study) - PT

Consentimento livre e informado

O presente estudo intitulado “A Virtual Reality based tool for learning Basic Design: A pilot study” tem como principal objetivo desenvolver e testar uma ferramenta de aprendizagem com base na Realidade Virtual, no âmbito da Unidade Curricular Laboratório de Design 3D. Por conseguinte, a sua participação enquanto estudante do primeiro ano do curso de Design do IADE-U, será determinante nesta fase do projeto de investigação, com o qual visamos aumentar o conhecimento na área da educação e contribuir para a inovação no ensino do Design Básico.

A investigadora responsável por este estudo é a Professora Doutora Lucy Niemeyer, que pode ser contactada via correio eletrónico lucy.niemeyer@gmail.com em caso de dúvida.

O estudo decorrerá em paralelo e em estreita ligação com as atividades letivas ao longo do semestre, na unidade curricular Lab D3D.

Procedimento: Paralelamente à explicação do professor acerca do exercício a realizar nas aulas seguintes, ser-lhe-á pedido para interagir com as estruturas apresentadas em Realidade Virtual, por meio do teclado e rato do computador. Para visualizar as imagens projetadas em 3D será necessária a utilização de óculos semelhantes aos usados nos cinemas. A experiência terá a duração de 10 minutos e ao longo deste tempo será feito o registo pontual de imagens, por fotografia e por vídeo.

Este estudo não tem riscos nem custos para o participante. No entanto, excepcionalmente, pessoas mais sensíveis podem sentir tonturas ou enjoo devido ao uso de óculos 3D. Caso apresente algum destes sintomas durante o teste, informe de imediato o investigador, e a sessão será interrompida.

Todos os dados são confidenciais, isto é, a identidade dos participantes não será revelada fora deste estudo.

No final do estudo pode contactar-nos para mais informações sobre os resultados.

A participação é voluntária e é possível abandonar a experiência a qualquer momento sem qualquer consequência.

Muito obrigado pela participação.

Li, compreendi e aceito todas as condições de participação neste estudo.

(Assinatura do estudante)

B. Script for presenting the exercise to the students (pilot study)

- PT

Este momento visa a apresentação do 2º exercício, intitulado Sistema Dinâmico Modulado 3D, a realizar durante as próximas quatro semanas, na unidade curricular Laboratório de Design 3D.

Seguidamente serão introduzidos os objetivos do exercício, bem como os procedimentos e materiais a utilizar e em simultâneo, terão a oportunidade de interagir com estruturas semelhantes aquelas que irão realizar, recorrendo à Realidade Virtual.

Assim, com o rato do computador pode selecionar no dropdown ESTRUTURAS cada uma das seis peças. São apresentados dois sistemas modulados, referindo-se as peças A, B e C a um deles, e as peças D, E e F, a outro diferente, sendo o critério para tal distinção a utilização de diferentes partes elementares. Uma vez ativada, cada estrutura pode ser manipulada através dos comandos ESCALA, deslizando o rato; ROTAÇÃO, introduzindo a amplitude nos respetivos eixos; e TRANSLAÇÃO, deslizando o rato sobre a linha de cada eixo. Para se movimentarem ao redor de cada peça, basta deslizar o rato enquanto primem o botão esquerdo. Podem ainda mudar o MATERIAL de cada estrutura e alterar a ILUMINAÇÃO. A opção ANIMAÇÃO está apenas disponível para duas estruturas, C e F. Finalmente, ao clicar em DETALHE são revelados os conceitos aplicados a cada caso, de acordo com as 4 categorias: CLASSE DE IGUALDADE OU SEMELHANÇA: isometria (B, D e F), homeometria (C) e singenometria (A e E); OPERAÇÕES DE SIMETRIA: translação (A, D e F), rotação (B, E), reflexão especular (C) e dilatação (C); TIPO DE LIGAÇÃO: peça única (A, B, C e E) peça subdividida (D) ou ambas (F); e FORMA DA LIGAÇÃO: reta (B, C e E), peça curva (D e F), ou combinação de reta e curva (A e C).

Objetivos:

Aplicando o processo morfogenético e o princípio da máxima diversidade com o mínimo reportório, utilizados no exercício anterior, o exercício consiste na criação/construção de um sistema modulado 3D. Deste sistema é necessário apresentar 3 efeitos visuais (i.e., 3 motivos elementares). O objetivo do exercício é destacar, não só a diversidade de efeitos, mas também qualidade estética e técnica de cada peça, bem como do seu conjunto.

Procedimentos e materiais:

As estruturas abstratas serão construídas manualmente, em K-line branco, de 3 mm de espessura, recorrendo somente a encaixes para a obtenção de consistência estrutural. Cada peça deverá utilizar entre 10 e 12 partes elementares dispostas em série ao longo de uma ligação. Esta deve ficar embebida nas partes elementares, ou seja, à face de uma superfície do sólido. A peça F consiste num exemplo a não seguir, opondo-se por isso, à D, que já apresenta a ligação corretamente encaixada.

A parte elementar do sistema será gerada em 2D, a partir de um dos painéis de Le Corbusier, (i.e., o marco de referência).

C. Questionnaire before exercise 1 (moment 1): Demographic data - PT

Questionário aos alunos da UC: Laboratório de Design 3D

Ano letivo 2015-16, 2º semestre

Turma:

1. Dados demográficos

1.1. Nome completo: _____

1.2. Masculino _____ Feminino _____

1.3. Data de nascimento (d/m/a): ____/____/____

1.4. Trabalhador-estudante: Sim _____ Não _____

1.4.1. Se sim, nº de horas de trabalho por semana (aprox.): _____

1.5. Nacionalidade: _____

2. Formação

2.1. 12º ano de escolaridade completo: Sim _____ Não _____

2.2. Outra situação, qual: _____

2.3. Área de estudo: _____

2.4. País/países onde estudou _____

3. Primeira vez no ensino superior

3.1. É a 1ª vez que frequenta o ensino superior? Sim _____ Não _____

3.1.1. Se não, indique que curso(s) superior(es) frequentou: _____

3.1.2. E/ou, que curso(s) superior(es) concluiu: _____

3. Competências

Assinale **X** no nível de competências a seguir descritas, tendo como referência uma escala de 1 a 5, em que: 1 – não domino; 2 – domino pouco; 3 – domino razoavelmente; 4 – domino bem; 5 – pleno domínio

4.1. Métodos **digitais** de modelação e representação 3D

AutoCAD: 1 2 3 4 5

SketchUp: 1 2 3 4 5

Outros, quais? _____ 1 2 3 4 5

Outros, quais? _____ 1 2 3 4 5

4.2. Métodos **manuais** de modelação e representação 3D:

papel, cartolina, tesoura, X-ato: 1 2 3 4 5

madeira, balsa: 1 2 3 4

cerâmica: 1 2 3 4

Outros, quais? _____ 1 2 3 4 5

Outros, quais? _____ 1 2 3 4 5

5. Estilos de aprendizagem

5. Aprendo mais facilmente com recursos do tipo:

visual _____ auditivo _____ cinestésico (fazendo) _____

digital _____ analógico (manual) _____

6. Área vocacional

6. Tenho mais interesse na(s) seguinte(s) área(s) do design:

Ambientes _____ industrial _____ visual _____ não sei _____

Outra(s), qual/quais? _____

7. Expectativas Lab D3D

7.1. Espero desenvolver os seguintes tópicos, no âmbito da UC Lab D3D:

cor_____ forma_____ textura_____ abstração_____ figuração_____

trabalhos em grupo_____ trabalhos individuais_____

modelização digital_____ modelização manual/analógica_____

representações 2D_____ representações 3D_____

outros:_____

8. Experiência com a Realidade Virtual

8.1. Já teve experiências em Realidade Virtual?

não_____ sim_____ n.sei_____

8.2. Se sim, qual/quais:_____

Muito obrigada pela colaboração :)

D. Questionnaire before exercise 1 (moment 1): Creativity level; and perception of barriers to personal creativity inventory- PT

Seção 1 de 3

Antes do 1º exercício

2015-16

Nome

*

Texto de resposta longa

Seção 2 de 3

Nível de criatividade

Das seguintes possibilidades de resposta, assinale apenas uma.

Qual o seu nível de criatividade?

*

nada criativo

pouco criativo

moderadamente
criativo

muito criativo

extremamente
criativo

Seção 3 de 3

Perceção das barreias à criatividade

Este questionário pretende conhecer a sua opinião acerca das barreiras que o impedem de ser mais criativo.

Responda de acordo com a seguinte escala de 1 a 5: (1 discordo plenamente; 2 discordo pouco; 3 não discordo nem concordo; 4 concordo pouco; 5 concordo plenamente)

1. Eu seria mais criativo(a) se acreditasse mais em mim.

1

2

3

4

5

Discordo
plenamente

Concordo
plenamente

2. Eu seria mais criativo(a) se fosse menos tímido(a) para expor as minhas ideias.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

3. Eu seria mais criativo(a) se fosse mais espontâneo(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

4. Eu seria mais criativo(a) se não fosse tão inseguro(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

5. Eu seria mais criativo(a) se estivesse disposto(a) a correr mais riscos.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

6. Eu seria mais criativo(a) se não tivesse medo de contrariar as pessoas.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

7. Eu seria mais criativo(a) se não fosse tão acomodado(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

8. Eu seria mais criativo(a) se fosse menos preguiçoso(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

9. Eu seria mais criativo(a) se tivesse mais motivação para criar.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

10. Eu seria mais criativo(a) se tivesse mais tempo.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

11. Eu seria mais criativo(a) se não tivesse medo de enfrentar o desconhecido.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

12. Eu seria mais criativo(a) se houvesse maior reconhecimento do trabalho criativo.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

13. Eu seria mais criativo(a) se exercitasse mais o hábito de procurar ideias novas.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

14. Eu seria mais criativo(a) se não tivesse medo de enfrentar as críticas.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

15. Eu seria mais criativo(a) se não tivesse medo de expressar o que penso.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

16. Eu seria mais criativo(a) se tivesse sido mais estimulado(a) pelos meus professores.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

17. Eu seria mais criativo(a) se não tivesse medo de executar as minhas ideias

1	2	3	4	5
Discordo plenamente				Concordo plenamente

18. Eu seria mais criativo(a) se fosse mais extrovertido(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

19. Eu seria mais criativo(a) se não me sentisse inferior aos outros.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

20. Eu seria mais criativo(a) se não tivesse medo de ser incompreendido(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

21. Eu seria mais criativo(a) se tivesse mais tempo para elaborar as minhas ideias.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

22. Eu seria mais criativo(a) se não tivesse sido limitado(a) pela família.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

23. Eu seria mais criativo(a) se tivesse mais oportunidade de por em prática as minhas ideias.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

24. Eu seria mais criativo(a) se não tivesse medo do que os outros irão pensar de mim.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

25. Eu seria mais criativo(a) se tivesse mais oportunidade para explorar o meu potencial.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

26. Eu seria mais criativo(a) se não tivesse recebido uma educação tão rígida.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

27. Eu seria mais criativo(a) se não tivesse sido limitado(a) pelos meus professores.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

28. Eu seria mais criativo(a) se tivesse tido mais oportunidades para errar sem ser considerado(a) estúpido(a) ou idiota.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

29. Eu seria mais criativo(a) se fosse menos criticado(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

30. Eu seria mais criativo(a) se fosse mais persistente.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

31. Eu seria mais criativo(a) se as minhas ideias fossem mais valorizadas.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

32. Eu seria mais criativo(a) se houvesse mais cooperação entre as pessoas.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

33. Eu seria mais criativo(a) se houvesse maior aceitação da fantasia no meio em que vivo.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

34. Eu seria mais criativo(a) se as pessoas valorizassem mais as ideias novas.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

35. Eu seria mais criativo(a) se houvesse mais respeito pelas diferenças entre as pessoas.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

36. Eu seria mais criativo(a) se fosse menos autoritário(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

37. Eu seria mais criativo(a) se não fosse tão crítico(a) em relação às ideias dos outros.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

38. Eu seria mais criativo(a) se fosse mais dedicado(a) ao que faço.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

39. Eu seria mais criativo(a) se tivesse mais energia.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

40. Eu seria mais criativo(a) se fosse mais rico em ideias.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

41. Eu seria mais criativo(a) se fosse mais concentrado(a) no que faço.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

42. Eu seria mais criativo(a) se fosse mais curioso(a).

1	2	3	4	5
Discordo plenamente				Concordo plenamente

43. Eu seria mais criativo(a) se tivesse mais entusiasmo.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

44. Eu seria mais criativo(a) se tivesse mais conhecimentos.

1	2	3	4	5
Discordo plenamente				Concordo plenamente

E. Questionnaire after exercise 1 (moment 2): Perception of creativity; and perception of motivation - PT

Seção 1 de 3

1º exercício

2015-16

Nome

*

Texto de resposta longa

Seção 2 de 3

Perceção da criatividade

Este questionário pretende conhecer a sua opinião acerca do exercício que acabou de concluir.

Responda de acordo com a seguinte escala de 1 a 5 (1 discordo plenamente; 2 discordo pouco; 3 não discordo nem concordo; 4 concordo pouco; 5 concordo plenamente)

1. Ao realizar este exercício eu acreditei em mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

2. Ao realizar este exercício não fui tímido(a) para expor as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

3. Ao realizar este exercício fui espontâneo(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

4. Ao realizar este exercício senti-me inseguro(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

5. Ao realizar este exercício senti que podia correr riscos.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

6. Ao realizar este exercício tive medo de contrariar as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

7. Ao realizar este exercício não me acomodei.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

8. Ao realizar este exercício não fui preguiçoso(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

9. Ao realizar este exercício não senti motivação para criar.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

10. Ao realizar este exercício não senti necessidade de mais tempo para criar.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

11. Ao realizar este exercício tive medo de enfrentar o desconhecido (arriscar).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

12. Ao realizar este exercício não senti reconhecimento do trabalho criativo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

13. Ao realizar este exercício exercitei o hábito de procurar ideias novas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

14. Ao realizar este exercício receei enfrentar as críticas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

15. Ao realizar este exercício não receei expressar o que penso.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

16. Ao realizar este exercício fui estimulado(a) pelos meus professores a ser criativo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

17. Ao realizar este exercício tive medo de executar as minhas ideias

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

18. Ao realizar este exercício fui extrovertido(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

19. Ao realizar este exercício senti-me inferior aos outros.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

20. Ao realizar este exercício não tive medo de ser incompreendido(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

21. Ao realizar este exercício tive tempo para elaborar as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

22. Ao realizar este exercício não me senti limitado(a) pela família.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

23. Ao realizar este exercício tive oportunidade de por em prática as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

24. Ao realizar este exercício não me preocupei com o que os outros iriam pensar de mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

25. Ao realizar este exercício não tive oportunidade para explorar o meu potencial.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

26. Ao realizar este exercício senti-me afetado (a) pela educação rígida que tive.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

27. Ao realizar este exercício não me senti limitado(a) pelos meus professores.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

28. Ao realizar este exercício tive oportunidades para errar sem ser considerado(a) estúpido(a) ou idiota.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

29. Ao realizar este exercício fui criticado(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

30. Ao realizar este exercício não fui persistente.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

31. Ao realizar este exercício as minhas ideias não foram mais valorizadas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

32. Ao realizar este exercício não houve cooperação entre as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

33. Ao realizar este exercício teria sido mais criativo se no meio em que vivo, tivesse havido mais aceitação da fantasia.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

34. Ao realizar este exercício não senti que as pessoas valorizaram mais as ideias novas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

35. Eu seria mais criativo(a) se houvesse mais respeito pelas diferenças entre as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

36. Eu seria mais criativo(a) se fosse menos autoritário(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

37. Eu seria mais criativo(a) se não fosse tão crítico(a) em relação às ideias dos outros.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

38. Eu seria mais criativo(a) se fosse mais dedicado(a) ao que faço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

39. Eu seria mais criativo(a) se tivesse mais energia.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

40. Eu seria mais criativo(a) se fosse mais rico em ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

41. Eu seria mais criativo(a) se fosse mais concentrado(a) no que faço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

42. Eu seria mais criativo(a) se fosse mais curioso(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

43. Eu seria mais criativo(a) se tivesse mais entusiasmo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

44. Eu seria mais criativo(a) se tivesse mais conhecimentos.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

Seção 3 de 3

Percepção da motivação

Este questionário pretende conhecer a sua opinião acerca do exercício que acabou de concluir. Responda de acordo com a seguinte escala de 1 a 5 (1 discordo plenamente; 2 discordo pouco; 3 não discordo nem concordo; 4 concordo pouco; 5 concordo plenamente)

A1. Algo interessante no início deste exercício despertou a minha atenção.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C2. Depois das informações introdutórias senti confiança relativamente aquilo que deveria aprender com este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S3. A realização do exercício deu-me uma sensação gratificante.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R4. Realizar este exercício com sucesso foi importante para mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S5. Gostei tanto deste exercício que estou interessado em conhecer mais sobre este tópico.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A6. O conteúdo deste exercício pareceu-me vazio e desagradável.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R7. O conteúdo deste exercício foi relevante para os meus interesses.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A8. Alguma coisa neste exercício estimulou a minha curiosidade.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S9. Gostei realmente de realizar este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A10. Por vezes, a quantidade de repetição neste exercício causou-me aborrecimento.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R11. Deu-me a impressão de que o conteúdo deste exercício valia a pena.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A12. Aprendi algumas coisas surpreendentes ou inesperadas com este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C13. Depois de trabalhar neste exercício por um tempo fiquei confiante de que conseguiria criar um novo trabalho.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S14. A avaliação do exercício ajudou-me a sentir recompensado pelo meu esforço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A15. A variedade de situações ao longo do exercício ajudou-me a manter a atenção durante o tempo que decorreu.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S16. Senti-me bem ao concluir este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R17. O conteúdo deste exercício será útil para mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C18. A boa organização do conteúdo ajudou-me a ter a certeza de que iria aprender com facilidade.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S19. Foi um prazer realizar um exercício tão bem concebido.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

F. Questionnaire after exercise 2 (moment 3): Perception of creativity; and perception of motivation - PT

Seção 1 de 3

2º exercício

2015-16

Nome

*

Texto de resposta longa

Seção 2 de 3

Perceção da criatividade

Este questionário pretende conhecer a sua opinião acerca do exercício que acabou de concluir. Responda de acordo com a seguinte escala de 1 a 5 (1 discordo plenamente; 2 discordo pouco; 3 não discordo nem concordo; 4 concordo pouco; 5 concordo plenamente)

1. Ao realizar este exercício eu acreditei em mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

2. Ao realizar este exercício não fui tímido(a) para expor as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

3. Ao realizar este exercício fui espontâneo(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

4. Ao realizar este exercício senti-me inseguro(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

5. Ao realizar este exercício senti que podia correr riscos.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

6. Ao realizar este exercício tive medo de contrariar as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

7. Ao realizar este exercício não me acomodei.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

8. Ao realizar este exercício não fui preguiçoso(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

9. Ao realizar este exercício não senti motivação para criar.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

10. Ao realizar este exercício não senti necessidade de mais tempo para criar.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

11. Ao realizar este exercício tive medo de enfrentar o desconhecido (arriscar).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

12. Ao realizar este exercício não senti reconhecimento do trabalho criativo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

13. Ao realizar este exercício exercitei o hábito de procurar ideias novas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

14. Ao realizar este exercício receei enfrentar as críticas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

15. Ao realizar este exercício não receei expressar o que penso.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

16. Ao realizar este exercício fui estimulado(a) pelos meus professores a ser criativo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

17. Ao realizar este exercício tive medo de executar as minhas ideias

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

18. Ao realizar este exercício fui extrovertido(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

19. Ao realizar este exercício senti-me inferior aos outros.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

20. Ao realizar este exercício não tive medo de ser incompreendido(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

21. Ao realizar este exercício tive tempo para elaborar as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

22. Ao realizar este exercício não me senti limitado(a) pela família.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

23. Ao realizar este exercício tive oportunidade de por em prática as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

24. Ao realizar este exercício não me preocupei com o que os outros iriam pensar de mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

25. Ao realizar este exercício não tive oportunidade para explorar o meu potencial.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

26. Ao realizar este exercício senti-me afetado (a) pela educação rígida que tive.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

27. Ao realizar este exercício não me senti limitado(a) pelos meus professores.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

28. Ao realizar este exercício tive oportunidades para errar sem ser considerado(a) estúpido(a) ou idiota.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

29. Ao realizar este exercício fui criticado(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

30. Ao realizar este exercício não fui persistente.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

31. Ao realizar este exercício as minhas ideias não foram mais valorizadas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

32. Ao realizar este exercício não houve cooperação entre as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

33. Ao realizar este exercício teria sido mais criativo se no meio em que vivo, tivesse havido mais aceitação da fantasia.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

34. Ao realizar este exercício não senti que as pessoas valorizaram mais as ideias novas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

35. Eu seria mais criativo(a) se houvesse mais respeito pelas diferenças entre as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

36. Eu seria mais criativo(a) se fosse menos autoritário(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

37. Eu seria mais criativo(a) se não fosse tão crítico(a) em relação às ideias dos outros.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

38. Eu seria mais criativo(a) se fosse mais dedicado(a) ao que faço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

39. Eu seria mais criativo(a) se tivesse mais energia.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

40. Eu seria mais criativo(a) se fosse mais rico em ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

41. Eu seria mais criativo(a) se fosse mais concentrado(a) no que faço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

42. Eu seria mais criativo(a) se fosse mais curioso(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

43. Eu seria mais criativo(a) se tivesse mais entusiasmo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

44. Eu seria mais criativo(a) se tivesse mais conhecimentos.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

Seção 3 de 3

Percepção da motivação

Este questionário pretende conhecer a sua opinião acerca do exercício que acabou de concluir. Responda de acordo com a seguinte escala de 1 a 5 (1 discordo plenamente; 2 discordo pouco; 3 não discordo nem concordo; 4 concordo pouco; 5 concordo plenamente)

A1. Algo interessante no início deste exercício despertou a minha atenção.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C2. Depois das informações introdutórias senti confiança relativamente aquilo que deveria aprender com este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S3. A realização do exercício deu-me uma sensação gratificante.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R4. Realizar este exercício com sucesso foi importante para mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S5. Gostei tanto deste exercício que estou interessado em conhecer mais sobre este tópico.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A6. O conteúdo deste exercício pareceu-me vazio e desagradável.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R7. O conteúdo deste exercício foi relevante para os meus interesses.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A8. Alguma coisa neste exercício estimulou a minha curiosidade.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S9. Gostei realmente de realizar este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A10. Por vezes, a quantidade de repetição neste exercício causou-me aborrecimento.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R11. Deu-me a impressão de que o conteúdo deste exercício valia a pena.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A12. Aprendi algumas coisas surpreendentes ou inesperadas com este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C13. Depois de trabalhar neste exercício por um tempo fiquei confiante de que conseguiria criar um novo trabalho.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S14. A avaliação do exercício ajudou-me a sentir recompensado pelo meu esforço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A15. A variedade de situações ao longo do exercício ajudou-me a manter a atenção durante o tempo que decorreu.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S16. Senti-me bem ao concluir este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R17. O conteúdo deste exercício será útil para mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C18. A boa organização do conteúdo ajudou-me a ter a certeza de que iria aprender com facilidade.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S19. Foi um prazer realizar um exercício tão bem concebido.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

G. Questionnaire after exercise 3 (moment 4): Creativity level; perception of creativity; and perception of motivation - PT

Seção 1 de 4

3º exercício

2015-16

Nome

*

Texto de resposta longa

Seção 2 de 4

Nível de criatividade

Das seguintes possibilidades de resposta, assinale apenas uma.

Qual o seu nível de criatividade?

*

nada criativo

pouco criativo

moderadamente
criativo

muito criativo

extremamente
criativo

Seção 3 de 4

Perceção da criatividade

Este questionário pretende conhecer a sua opinião acerca do exercício que acabou de concluir.

Responda de acordo com a seguinte escala de 1 a 5 (1 discordo plenamente; 2 discordo pouco; 3 não discordo nem concordo; 4 concordo pouco; 5 concordo plenamente)

1. Ao realizar este exercício eu acreditei em mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

2. Ao realizar este exercício não fui tímido(a) para expor as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

3. Ao realizar este exercício fui espontâneo(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

4. Ao realizar este exercício senti-me inseguro(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

5. Ao realizar este exercício senti que podia correr riscos.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

6. Ao realizar este exercício tive medo de contrariar as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

7. Ao realizar este exercício não me acomodei.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

8. Ao realizar este exercício não fui preguiçoso(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

9. Ao realizar este exercício não senti motivação para criar.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

10. Ao realizar este exercício não senti necessidade de mais tempo para criar.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

11. Ao realizar este exercício tive medo de enfrentar o desconhecido (arriscar).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

12. Ao realizar este exercício não senti reconhecimento do trabalho criativo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

13. Ao realizar este exercício exercitei o hábito de procurar ideias novas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

14. Ao realizar este exercício receei enfrentar as críticas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

15. Ao realizar este exercício não receei expressar o que penso.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

16. Ao realizar este exercício fui estimulado(a) pelos meus professores a ser criativo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

17. Ao realizar este exercício tive medo de executar as minhas ideias

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

18. Ao realizar este exercício fui extrovertido(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

19. Ao realizar este exercício senti-me inferior aos outros.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

20. Ao realizar este exercício não tive medo de ser incompreendido(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

21. Ao realizar este exercício tive tempo para elaborar as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

22. Ao realizar este exercício não me senti limitado(a) pela família.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

23. Ao realizar este exercício tive oportunidade de por em prática as minhas ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

24. Ao realizar este exercício não me preocupei com o que os outros iriam pensar de mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

25. Ao realizar este exercício não tive oportunidade para explorar o meu potencial.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

26. Ao realizar este exercício senti-me afetado (a) pela educação rígida que tive.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

27. Ao realizar este exercício não me senti limitado(a) pelos meus professores.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

28. Ao realizar este exercício tive oportunidades para errar sem ser considerado(a) estúpido(a) ou idiota.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

29. Ao realizar este exercício fui criticado(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

30. Ao realizar este exercício não fui persistente.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

31. Ao realizar este exercício as minhas ideias não foram mais valorizadas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

32. Ao realizar este exercício não houve cooperação entre as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

33. Ao realizar este exercício teria sido mais criativo se no meio em que vivo, tivesse havido mais aceitação da fantasia.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

34. Ao realizar este exercício não senti que as pessoas valorizaram mais as ideias novas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

35. Eu seria mais criativo(a) se houvesse mais respeito pelas diferenças entre as pessoas.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

36. Eu seria mais criativo(a) se fosse menos autoritário(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

37. Eu seria mais criativo(a) se não fosse tão crítico(a) em relação às ideias dos outros.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

38. Eu seria mais criativo(a) se fosse mais dedicado(a) ao que faço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

39. Eu seria mais criativo(a) se tivesse mais energia.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

40. Eu seria mais criativo(a) se fosse mais rico em ideias.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

41. Eu seria mais criativo(a) se fosse mais concentrado(a) no que faço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

42. Eu seria mais criativo(a) se fosse mais curioso(a).

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

43. Eu seria mais criativo(a) se tivesse mais entusiasmo.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

44. Eu seria mais criativo(a) se tivesse mais conhecimentos.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

Perceção da motivação

Este questionário pretende conhecer a sua opinião acerca do exercício que acabou de concluir. Responda de acordo com a seguinte escala de 1 a 5 (1 discordo plenamente; 2 discordo pouco; 3 não discordo nem concordo; 4 concordo pouco; 5 concordo plenamente)

A1. Algo interessante no início deste exercício despertou a minha atenção.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C2. Depois das informações introdutórias senti confiança relativamente aquilo que deveria aprender com este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S3. A realização do exercício deu-me uma sensação gratificante.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R4. Realizar este exercício com sucesso foi importante para mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S5. Gostei tanto deste exercício que estou interessado em conhecer mais sobre este tópico.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A6. O conteúdo deste exercício pareceu-me vazio e desagradável.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R7. O conteúdo deste exercício foi relevante para os meus interesses.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A8. Alguma coisa neste exercício estimulou a minha curiosidade.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S9. Gostei realmente de realizar este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A10. Por vezes, a quantidade de repetição neste exercício causou-me aborrecimento.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R11. Deu-me a impressão de que o conteúdo deste exercício valia a pena.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A12. Aprendi algumas coisas surpreendentes ou inesperadas com este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C13. Depois de trabalhar neste exercício por um tempo fiquei confiante de que conseguiria criar um novo trabalho.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S14. A avaliação do exercício ajudou-me a sentir recompensado pelo meu esforço.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

A15. A variedade de situações ao longo do exercício ajudou-me a manter a atenção durante o tempo que decorreu.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S16. Senti-me bem ao concluir este exercício.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

R17. O conteúdo deste exercício será útil para mim.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

C18. A boa organização do conteúdo ajudou-me a ter a certeza de que iria aprender com facilidade.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

S19. Foi um prazer realizar um exercício tão bem concebido.

*

1	2	3	4	5
Discordo plenamente				Concordo plenamente

H. Results of the pilot study: Statistics.

Table 1. Creativity level between subjects: mean.

Ranks				
	Grup	N	Mean Rank	Sum of Ranks
CreativityLevel_Moment1	experimental	10	9,50	95,00
	controlo	10	11,50	115,00
	Total	20		
CreativityLevel_Moment2	experimental	10	10,50	105,00
	controlo	10	10,50	105,00
	Total	20		

Table 2. Creativity level between subjects: Mann-Whitney test.

Test Statistics ^a		
	Nívelcriatividade Momento1	NívelCriatividade e Momento2
Mann-Whitney U	40,000	50,000
Wilcoxon W	95,000	105,000
Z	-,951	,000
Asymp. Sig. (2-tailed)	,342	1,000
Exact Sig. [2*(1-tailed Sig.)]	,481 ^b	1,000 ^b

a. Grouping Variable: Group

b. Not corrected for ties.

Table 3. Creativity level within subjects: Wilcoxon Signed-Ranks test.

Test Statistics ^a		
	CreativityExp2 - CreativityExp1	CreativityCont2 - CreativityCont 1
Z	-1,000 ^b	,000 ^c
Asymp. Sig. (2-tailed)	,317	1,000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

c. The sum of negative ranks equals the sum of positive ranks.

Table 4. Barriers to Personal Creativity.

	Grup		Result
Barriers to Personal Creativity (BPC)	Experimental Mean (SD)	Control Mean (SD)	
BPC_total1_I	3.01 (.78)	3.39 (.73)	$F(1,18) = 1.23, p = .28$
BPC_total1_II	3.47 (.51)	3.80 (.39)	$F(1,18) = 2.677, p = .12$
BPC_total1_III	2.57 (1.01)	2.77 (.85)	$F(1,18) = .223, p = .65$
BPC_total1_IV	3.33 (.84)	3.93 (.44)	$F(1,18) = 4.40, p = .06$
BPC_total2_I	2.92 (.35)	2.83 (.43)	$F(1,18) = .283, p = .60$
BPC_total2_II	2.72 (.44)	2.87 (.38)	$F(1,18) = .671, p = .42$
BPC_total2_III	2.90 (.34)	2.99 (.49)	$F(1,18) = .014, p = .91$
BPC_total2_IV	3.30 (.52)	3.37 (.63)	$F(1,18) = .065, p = .80$
BPC_total3_I	2.94 (.40)	2.95 (.17)	$F(1,18) = .012, p = .91$
BPC_total3_II	2.60 (.37)	2.86 (.40)	$F(1,18) = 2.28, p = .15$
BPC_total3_III	3.00 (.24)	2.80 (.26)	$F(1,18) = 3.26, p = .09$
BPC_total3_IV	3.09 (.70)	3.04 (.71)	$F(1,18) = .023, p = .88$
BPC_total4_I	2.89 (.35)	3.08 (.38)	$F(1,18) = 1.36, p = .26$
BPC_total4_II	2.57 (.39)	2.81 (.37)	$F(1,18) = 2.03, p = .17$
BPC_total4_III	2.73 (.61)	3.04 (.27)	$F(1,18) = 2.19, p = .16$
BPC_total4_IV	2.87 (.80)	3.31 (.52)	$F(1,18) = 2.05, p = .17$

Table 5. Motivation between subjects

	Grup		Result
Motivation	Experimental Mean (SD)	Control Mean (SD)	
Total1_A	3.00 (.44)	3.47 (.29)	$F(1,18) = 7.92, p = .01$
Total1_S	3.37 (.94)	3.72 (.70)	$F(1,18) = .87, p = .36$
Total1_C	3.20 (.95)	3.70 (.69)	$F(1,18) = 1.83, p = .19$
Total1_R	3.20 (.90)	3.50 (.60)	$F(1,18) = .76, p = .39$
Total2_A	3.18 (.36)	3.33 (.44)	$F(1,18) = .71, p = .41$
Total2_S	3.78 (.77)	.49 (.26)	$F(1,18) = 165.26, p < .001$
Total2_C	3.53 (.59)	3.57 (.72)	$F(1,18) = .014, p = .91$
Total2_R	3.63 (.82)	3.55 (.83)	$F(1,18) = .04, p = .84$
Total3_A	2.96 (.25)	3.22 (.66)	$F(1,18) = 1.33, p = .27$
Total3_S	3.08 (.26)	3.78 (.89)	$F(1,18) = 5.81, p = .03$

Total3_C	3.27 (.42)	3.57 (.92)	$F(1,18) = .89, p = .36$
Total3_R	3.17 (.43)	3.55 (1.15)	$F(1,18) = .94, p = .35$

Table 6. Motivation within subjects: experimental group.

Tests of Within-Subjects Effects							
Measure: MEASURE_1							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Motivation_	Sphericity Assumed	2,288	3	,763	2,729	,064	,233
	Greenhouse-Geisser	2,288	1,759	1,301	2,729	,101	,233
	Huynh-Feldt	2,288	2,153	1,063	2,729	,087	,233
	Lower-bound	2,288	1,000	2,288	2,729	,133	,233
Error(Motivation)	Sphericity Assumed	7,545	27	,279			
	Greenhouse-Geisser	7,545	15,832	,477			
	Huynh-Feldt	7,545	19,380	,389			
	Lower-bound	7,545	9,000	,838			
Moment	Sphericity Assumed	3,849	2	1,925	2,152	,145	,193
	Greenhouse-Geisser	3,849	1,279	3,009	2,152	,168	,193
	Huynh-Feldt	3,849	1,397	2,754	2,152	,164	,193
	Lower-bound	3,849	1,000	3,849	2,152	,176	,193
Error(Moment)	Sphericity Assumed	16,094	18	,894			
	Greenhouse-Geisser	16,094	11,511	1,398			
	Huynh-Feldt	16,094	12,577	1,280			
	Lower-bound	16,094	9,000	1,788			
Motivation_ * Moment	Sphericity Assumed	,831	6	,138	1,244	,299	,121
	Greenhouse-Geisser	,831	3,171	,262	1,244	,313	,121
	Huynh-Feldt	,831	5,097	,163	1,244	,304	,121
	Lower-bound	,831	1,000	,831	1,244	,294	,121

Error(Motivation*Momen)	Sphericity Assumed	6,008	54	,111			
	Greenhouse-Geisser	6,008	28,538	,211			
	Huynh-Feldt	6,008	45,869	,131			
	Lower-bound	6,008	9,000	,668			

Table 7. Motivation within subjects: control group.

Tests of Within-Subjects Effects							
Measure: MEASURE_1							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Motivation	Sphericity Assumed	16,701	3	5,567	17,734	,000	,663
	Greenhouse-Geisser	16,701	2,417	6,909	17,734	,000	,663
	Huynh-Feldt	16,701	3,000	5,567	17,734	,000	,663
	Lower-bound	16,701	1,000	16,701	17,734	,002	,663
Error(Motivation)	Sphericity Assumed	8,476	27	,314			
	Greenhouse-Geisser	8,476	21,756	,390			
	Huynh-Feldt	8,476	27,000	,314			
	Lower-bound	8,476	9,000	,942			
Moment	Sphericity Assumed	18,298	2	9,149	7,175	,005	,444
	Greenhouse-Geisser	18,298	1,636	11,183	7,175	,009	,444
	Huynh-Feldt	18,298	1,950	9,382	7,175	,006	,444
	Lower-bound	18,298	1,000	18,298	7,175	,025	,444
Error(Moment)	Sphericity Assumed	22,952	18	1,275			
	Greenhouse-Geisser	22,952	14,726	1,559			
	Huynh-Feldt	22,952	17,554	1,308			
	Lower-bound	22,952	9,000	2,550			
Motivation * Moment	Sphericity Assumed	52,868	6	8,811	40,040	,000	,816
	Greenhouse-Geisser	52,868	3,388	15,605	40,040	,000	,816
	Huynh-Feldt	52,868	5,680	9,308	40,040	,000	,816
	Lower-bound	52,868	1,000	52,868	40,040	,000	,816
Error(Motivation * Moment)	Sphericity Assumed	11,883	54	,220			
	Greenhouse-Geisser	11,883	30,490	,390			
	Huynh-Feldt	11,883	51,121	,232			
	Lower-bound	11,883	9,000	1,320			

Table 8. Motivation: Pairwise comparisons.

Pairwise Comparisons						
Measure: MEASURE_1						
(I) Motiv	(J) Motiv	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
A	S	,675*	,136	,005	,216	1,134
	C	-,272	,143	,533	-,753	,208
	R	-,194	,176	1,000	-,786	,398
S	A	-,675*	,136	,005	-1,134	-,216
	C	-,947*	,128	,000	-1,378	-,516
	R	-,869*	,163	,003	-1,419	-,320
C	A	,272	,143	,533	-,208	,753
	S	,947*	,128	,000	,516	1,378
	R	,078	,112	1,000	-,299	,455
R	A	,194	,176	1,000	-,398	,786
	S	,869*	,163	,003	,320	1,419
	C	-,078	,112	1,000	-,455	,299

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Table 9. Performance between subjects and within subjects.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Grades_ex.1	Between Groups	5,000	1	5,000	,938	,346
	Within Groups	96,000	18	5,333		
	Total	101,000	19			
Grades_ex.2	Between Groups	3,200	1	3,200	,281	,603
	Within Groups	205,000	18	11,389		
	Total	208,200	19			
Grades_ex.3	Between Groups	6,050	1	6,050	,703	,413
	Within Groups	154,900	18	8,606		
	Total	160,950	19			
Final grades	Between Groups	14,450	1	14,450	1,905	,184
	Within Groups	136,500	18	7,583		
	Total	150,950	19			

I. Online questionnaire: Anticipating the impact of Virtual Reality for learning the design fundamentals – ENG

Jotform link: <https://form.jotform.com/211013320144332>

Anticipating the impact of Virtual Reality for learning the design fundamentals

My name is Ana Neves and I am conducting a research that aims the creation of a Virtual Reality (VR)-based tool for learning the design fundamentals. This survey intends to collect your perception about your previous experience in learning the major topics related to the design fundamentals; and your perception of how VR could improve learning those topics, in the future.

Participation in the study

Your participation in this study is anonymous and confidential. The collected data will be used only for the purpose of the study. Your contribution is entirely voluntary, so, feel free if you need/want to quit filling out the questionnaire, at any time during the process. Any question regarding the study can be addressed directly to ana.neves@universidadeuropeia.pt. Thank you in advance, for your time!

Informed consent *

☐

I am informed about the objectives of the study and I accept to participate by answering this questionnaire.

☐

I choose not to participate in the study.

Are you presently enrolled in an undergraduate degree in design, or have you concluded the degree during the last 4 academic years (the latest, in 2017-18)? *

☐

Yes

☐

No

What is/was the name of your undergraduate design degree? *

What is the name of the Higher Education institution that will award/awarded the undergraduate design degree? *

Learning the design fundamentals

In this section, we ask you to remember your experience of learning the design fundamentals during the undergraduate degree in design, which may have been in the first year of the design course. By design

fundamentals, we mean the theory-practice of the design elements and their rules of composition for 2D and 3D design. Design fundamentals include topics such as: color contrasts and harmonies; modularity and pattern creation; Gestalt laws; formal coherence; and so on.

During the undergraduate degree in design, did you attend a specific lecture for learning the design fundamentals? *

- ☐ yes
- ☐ no

In which semester(s) did you attend such lecture(s)? *

- ☐ 1st semester
- ☐ 2nd semester
- ☐ 3rd semester
- ☐ 4th semester
- ☐ 5th semester
- ☐ 6th semester

Lecture for learning the design fundamentals, in the 1st semester

Perception of relevance; ease of learning; and use of digital technologies

What was the name of the lecture that aimed the teaching-learning of the design fundamentals? In case you don't remember, point the closest you can. If there was more than one lecture per semester choose the one you consider more relevant. *

How do you perceive the relevance of the lecture for your performance in the subsequent semesters of the undergraduate degree? *

- 1 2 3 4 5
- very relevant ☐ ☐ ☐ ☐ ☐ little relevant

How easy was for you to learn the following topics?

- | | 1
Very
easy | 2
Moderately
easy | 3
Moderately
difficult | 4
Very
difficult | Does
not
apply |
|--|-----------------------|-------------------------|------------------------------|------------------------|-----------------------|
| Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.) | ☐ | ☐ | ☐ | ☐ | ☐ |

2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)	☐	☐	☐	☐	☐
3D principles of form creation (e.g., solids; structures; length-width-height; modularity-patterning; formal coherence; etc)	☐	☐	☐	☐	☐
Personal values and skills (autonomy; self-knowledge; collaboration; communication; resilience; curiosity; confidence)	☐	☐	☐	☐	☐
Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)	☐	☐	☐	☐	☐
Texture (e.g., tactile boards; visual textures; surface of objects; etc)	☐	☐	☐	☐	☐
Visual (perceptive) principles: parts-totality; macro-micro; figure-ground; layering; scale; proportions; etc)	☐	☐	☐	☐	☐

During the lecture, how do/did you perceive the use of digital technology?

	How often did you use them?	How helpful were they?	In an ideal situation, how often they should be used?
Authoring tools: for creation of content and information; communication and collaboration; learning assessment.			
Search, store and socialize content tools: for finding, saving and sharing information and content, in a diversity of digital formats.			
Virtual immersiveness tools: for experiences very similar to the real environment, for immersion in a virtual world.			
Assistive technologies: for the participation and access of people with disabilities to information and content, allowing more autonomy, learning and digital inclusion.			
Task management tools: for administration, organization and systematization of daily tasks, professional projects.			

Lecture for learning the design fundamentals, in the 2nd semester.

Perception of relevance; ease of learning; and use of digital technologies.

What was the name of the lecture that aimed the teaching-learning of the design fundamentals? In case you don't remember, point the closest you can. If there was more than one lecture per semester choose the one you consider more relevant. *

How do you perceive the relevance of the lecture for your performance in the subsequent semesters of the undergraduate degree? *

1 2 3 4 5

very relevant ☐ ☐ ☐ ☐ ☐ little relevant

How easy was it for you to learn the following topics?

	1 Very easy	2 Moderately easy	3 Moderately difficult	4 Very difficult	Does not apply
Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.)	☐	☐	☐	☐	☐
2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)	☐	☐	☐	☐	☐
3D principles of form creation (e.g., solids; structures; length-width-height; modularity-patterning; formal coherence; etc)	☐	☐	☐	☐	☐
Personal values and skills (autonomy; self-knowledge; collaboration; communication; resilience; curiosity; confidence)	☐	☐	☐	☐	☐
Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)	☐	☐	☐	☐	☐
Texture - (e.g., tactile boards; visual textures; surface of objects; etc)	☐	☐	☐	☐	☐
Visual (perceptive) principles: parts-totality; macro-micro; figure-ground; layering; scale; proportions; etc)	☐	☐	☐	☐	☐

During the lecture, how do you consider the use of digital technology?

	How often did you use them?	How helpful were they?	In an ideal situation, how often they should be used?
Authoring tools: for creation of content and information; communication and collaboration; learning assessment.			
Search, store and socialize content tools: for finding, saving and sharing information and content, in a diversity of digital formats.			
Virtual immersiveness tools: for experiences very similar to the real environment, for immersion in a virtual world.			
Assistive technologies: for the participation and access of people with disabilities to information and content, allowing more autonomy, learning and digital inclusion.			
Task management tools: for administration, organization and systematization of daily tasks, professional projects.			

Lecture for learning the design fundamentals, in the 3rd semester.

Perception of relevance; ease of learning; and use of digital technologies.

What was the name of the lecture that aimed the teaching-learning of the design fundamentals? In case you don't remember, point the closest you can. If there was more than one lecture per semester choose the one you consider more relevant. *

How do you perceive the relevance of the lecture for your performance in the subsequent semesters of the undergraduate degree? *

1 2 3 4 5
very relevant ☐ ☐ ☐ ☐ ☐ little relevant

How easy was it for you to learn the following topics?

1 2 3 4 5
Very Moderately Moderately Very Does
easy easy difficult difficult not
apply

Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.)	☐	☐	☐	☐	☐
2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)	☐	☐	☐	☐	☐
3D principles of form creation (e.g., solids; structures; length-width-height; modularity-patterning; formal coherence; etc)	☐	☐	☐	☐	☐
Personal values and skills (autonomy; self-knowledge; collaboration; communication; resilience; curiosity; confidence)	☐	☐	☐	☐	☐
Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)	☐	☐	☐	☐	☐
Texture - (e.g., tactile boards; visual textures; surface of objects; etc)	☐	☐	☐	☐	☐
Visual (perceptive) principles: parts-totality; macro-micro; figure-ground; layering; scale; proportions; etc)	☐	☐	☐	☐	☐

During the lecture, how do you consider the use of digital technology?

	How often did you use them?	How helpful were they?	In an ideal situation, how often they should be used?
Authoring tools: for creation of content and information; communication and collaboration; learning assessment.			
Search, store and socialize content tools: for finding, saving and sharing information and content, in a diversity of digital formats.			
Virtual immersiveness tools: for experiences very similar to the real environment, for immersion in a virtual world.			
Assistive technologies: for the participation and access of people with disabilities to information and content, allowing more autonomy, learning and digital inclusion.			

Task management tools: for administration, organization
and systematization of daily tasks, professional projects.

Lecture for learning the design fundamentals, in the 4th semester.

Perception of relevance; ease of learning; and use of digital technologies.

What was the name of the lecture that aimed the teaching-learning of the design fundamentals?
In case you don't remember, point the closest you can. If there was more than one lecture per
semester choose the one you consider more relevant. *

How do you perceive the relevance of the lecture for your performance in the subsequent
semesters of the undergraduate degree? *

1 2 3 4 5
very relevant ☐ ☐ ☐ ☐ ☐ little relevant

How easy was it for you to learn the following topics?

	1 Very easy	2 Moderately easy	3 Moderately difficult	4 Very difficult	Does not apply
Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.)	☐	☐	☐	☐	☐
2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)	☐	☐	☐	☐	☐
3D principles of form creation (e.g., solids; structures; length-width-height; modularity-patterning; formal coherence; etc)	☐	☐	☐	☐	☐
Personal values and skills (autonomy; self-knowledge; collaboration; communication; resilience; curiosity; confidence)	☐	☐	☐	☐	☐
Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)	☐	☐	☐	☐	☐
Texture - (e.g., tactile boards; visual textures; surface of objects; etc)	☐	☐	☐	☐	☐

Visual (perceptive) principles: parts-totality; macro-micro; figure-ground; layering; scale; proportions; etc)

☐ ☐ ☐ ☐ ☐

During the lecture, how do you consider the use of digital technology?

	How often did you use them?	How helpful were they?	In an ideal situation, how often they should be used?
Authoring tools: for creation of content and information; communication and collaboration; learning assessment.			
Search, store and socialize content tools: for finding, saving and sharing information and content, in a diversity of digital formats.			
Virtual immersiveness tools: for experiences very similar to the real environment, for immersion in a virtual world.			
Assistive technologies: for the participation and access of people with disabilities to information and content, allowing more autonomy, learning and digital inclusion.			
Task management tools: for administration, organization and systematization of daily tasks, professional projects.			

Lecture for learning the design fundamentals, in the 5th semester.

Perception of relevance; ease of learning; and use of digital technologies.

What was the name of the lecture that aimed the teaching-learning of the design fundamentals? In case you don't remember, point the closest you can. If there was more than one lecture per semester choose the one you consider more relevant. *

How do you perceive the relevance of the lecture for your performance in the subsequent semesters of the undergraduate degree? *

1 2 3 4 5
very relevant ☐ ☐ ☐ ☐ ☐ little relevant

How easy was for you to learn the following topics?

	1 Very easy	2 Moderately easy	3 Moderately difficult	4 Very difficult	Does not apply
Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.)	☐	☐	☐	☐	☐
2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)	☐	☐	☐	☐	☐
3D principles of form creation (e.g., solids; structures; length-width-height; modularity-patterning; formal coherence; etc)	☐	☐	☐	☐	☐
Personal values and skills (autonomy; self-knowledge; collaboration; communication; resilience; curiosity; confidence)	☐	☐	☐	☐	☐
Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)	☐	☐	☐	☐	☐
Texture - (e.g., tactile boards; visual textures; surface of objects; etc)	☐	☐	☐	☐	☐
Visual (perceptive) principles: parts-totality; macro-micro; figure-ground; layering; scale; proportions; etc)	☐	☐	☐	☐	☐

During the lecture, how do you consider the use of digital technology?

	How often did you use them?	How helpful were they?	In an ideal situation, how often they should be used?
Authoring tools: for creation of content and information; communication and collaboration; learning assessment.			
Search, store and socialize content tools: for finding, saving and sharing information and content, in a diversity of digital formats.			
Virtual immersiveness tools: for experiences very similar to the real environment, for immersion in a virtual world.			
Assistive technologies: for the participation and access of people with disabilities to information and content, allowing more autonomy, learning and digital inclusion.			

Task management tools: for administration, organization
and systematization of daily tasks, professional projects.

Lecture for learning the design fundamentals, in the 6th semester.

Perception of relevance; ease of learning; and use of digital technologies.

What was the name of the lecture that aimed the teaching-learning of the design fundamentals?
In case you don't remember, point the closest you can. If there was more than one lecture per
semester choose the one you consider more relevant. *

How do you perceive the relevance of the lecture for your performance in the subsequent
semesters of the undergraduate degree? *

1 2 3 4 5
very relevant ☐ ☐ ☐ ☐ ☐ little relevant

How easy was it for you to learn the following topics?

	1 Very easy	2 Moderately easy	3 Moderately difficult	4 Very difficult	Does not apply
Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.)	☐	☐	☐	☐	☐
2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)	☐	☐	☐	☐	☐
3D principles of form creation (e.g., solids; structures; length-width-height; modularity-patterning; formal coherence; etc)	☐	☐	☐	☐	☐
Personal values and skills (autonomy; self-knowledge; collaboration; communication; resilience; curiosity; confidence)	☐	☐	☐	☐	☐
Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)	☐	☐	☐	☐	☐
Texture - (e.g., tactile boards; visual textures; surface of objects; etc)	☐	☐	☐	☐	☐

Visual (perceptive) principles: parts-totality; macro-micro; figure-ground; layering; scale; proportions; etc)



During the lecture, how do you consider the use of digital technology tools?

	How often did you use them?	How helpful were they?	In an ideal situation, how often they should be used?
Authoring tools: for creation of content and information; communication and collaboration; learning assessment.			
Search, store and socialize content tools: for finding, saving and sharing information and content, in a diversity of digital formats.			
Virtual immersiveness tools: for experiences very similar to the real environment, for immersion in a virtual world.			
Assistive technologies: for the participation and access of people with disabilities to information and content, allowing more autonomy, learning and digital inclusion.			
Task management tools: for administration, organization and systematization of daily tasks, professional projects.			

Different uses of immersive Virtual Reality (iVR).

The following video shows some examples of iVR for art, illustration and design purposes. Please watch it before answering the questions.

What is your proficiency with immersive Virtual Reality (iVR) technology? *

- ☐ I am familiarised with iVR concept and I have had an iVR experience
- ☐ I am familiarised with iVR concept but never experienced it
- ☐ I am somewhat familiarised with iVR concept
- ☐ I am not familiarised with iVR concept
- ☐

In what area is your practice with Virtual Reality (iVR) technology? *

- ☐ Random experiences or curiosity trial
- ☐ Co-design and collaborative work
- ☐ Research projects
- ☐ Home entertainment
- ☐ Health purposes, such as physiotherapy or psychotherapy
- ☐ Contemplation, meditation activities
- ☐ Virtual meetings or classes
- ☐ Content developer
- ☐ Teaching and learning contexts
- ☐ Virtual visits to exhibitions or to otherwise inaccessible places
- ☐ None
- ☐

Perception of the impact of iVR technology for teaching and learning the design fundamentals

How do you evaluate the following statements? The use of iVR-based tools is likely to...

	1 strongly agree	2 agree	3 disagree	4 strongly disagree
... motivate students to the lecture	☐	☐	☐	☐
... have a major contribution to attaining the objectives of the lecture	☐	☐	☐	☐
... enable more focus and concentration during the tasks	☐	☐	☐	☐
... allow collaborative tasks	☐	☐	☐	☐
... support remotely (asynchronous and synchronous) activities	☐	☐	☐	☐
... favor presential/in-class activities	☐	☐	☐	☐
... support real time assessment	☐	☐	☐	☐
... favor student-teacher interaction	☐	☐	☐	☐
... allow creativity (imagination, spontaneity and curiosity)	☐	☐	☐	☐
... support self-learning and self-knowledge	☐	☐	☐	☐
... support simulations of authentic real-life contexts	☐	☐	☐	☐

... enable exploring different senses, other than visual (e.g.,
auditive, tactile, etc) and their combination

☐ ☐ ☐ ☐

What competencies do you expect an iVR-based tool enables you to perform? For each content
topic (at the left), choose one option in every four cognitive levels (i.e., actions that reflect how
learning is manifested)

	1st level	2nd level	3rd level	4th level
Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.)				
2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)				
3D principles of form creation (e.g., solids; structures; length- width-height; modularity-patterning; formal coherence; etc)				
Personal values and skills (autonomy; self- knowledge; collaboration; communication; resilience; curiosity; confidence)				
Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)				

Texture - (e.g., tactile

boards; visual textures;

surface of objects; etc)

Visual (perceptive)

principles: parts-

totality; macro-micro;

figure-ground; layering;

scale; proportions; etc)

Demographic data

Age *

Gender *

☐

Female

☐

Male

Nationality *

Thank you for collaborating!

Send

J. Online questionnaire: Anticipating the impact of Virtual Reality for learning the design fundamentals.

Jotform link: <https://form.jotform.com/211013320144332>

Conditional answers (Proceed to the questionnaire if the answers are positive.)

- Are you presently enrolled in an undergraduate degree in design, or have you concluded the degree during the last 4 academic years (the latest, in 2017-18)?
- During the undergraduate degree in design, did you attend a specific lecture for learning the design fundamentals?

1.1. Demographic data

1.1.1. Q1_Demographics

Table 10. Demographics

Quest. Nº	Name [line]	Variable
1.1	Age [1]	Age_1.1
1.2	Gender [2]	Gender_1.2
1.3	Nationality [3]	Nationality_1.3

1.1.2. Q2_What is/was the name of your undergraduate design degree?

Table 11. Name of the undergraduate design degree.

Quest. Nº	Name [line]	Variable
2	Nudd [4]	Name of the undergraduate design degree_2

1.1.3. Q3_What is the name of the Higher Education institution that will award/awarded the undergraduate design degree?

Table 12. Name of the Higher Education Institution

Quest. Nº	Name [line]	Variable
3	Nhei [5]	Name of the Higher Education Institution_3

1.2. Learning the design fundamentals

In this section, we ask you to remember your experience of learning the design fundamentals during the undergraduate degree in design, which may have been in the first year of the design course. By design fundamentals, we mean the theory-practice of the design elements and their rules of composition for 2D and 3D design. Design fundamentals include topics such as: color contrasts and harmonies; modularity and pattern creation; Gestalt laws; formal coherence; and so on.

1.2.1. Q4_In which semester(s) did you attend specific lecture(s) for learning the design fundamentals?

Table 13. Semester(s) in which were learned the design fundamentals.

Quest. Nº	Name [line]	Variable
4	Slect [6]	Semester(s) in which were learned the design fundamentals_4

1.2.2. Q5_What was the name of the lecture that aimed the teaching-learning of the design fundamentals? In case you don't remember, point the closest you can. If there was more than one lecture per semester choose the one you consider more relevant.

Table 14. Name of the lecture for leaning the design fundamentals, per learning period (semester).

Quest. Nº	Name [line]	Variable
5-1s	N1s [7]	Name of the lecture for leaning the design fundamentals, in the 1 st sem_5.1s
5-2s	N2s [8]	Name of the lecture for leaning the design fundamentals, in the 2 nd sem_5.2s
5-3s	N3s [9]	Name of the lecture for leaning the design fundamentals, in the 3 rd sem_5.3s
5-4s	N4s [10]	Name of the lecture for leaning the design fundamentals, in the 4 th sem_5.4s

1.3. Lecture for learning the design fundamentals, (in the first learning period that the content topics were lectured).

A new variable was created using only the data from the first learning period that the design fundamentals were learned, which, according to the respondents, occurred during the four first semesters.

Another reference to the fact that the tables relating to values present a left-right side to the numbered scale (in the middle). The left side of the table refers to the order presented in the questionnaire; and the right side, to the reordering of the values after the questionnaire, for enabling the subsequent analysis more fluidity. In this sense the growing in numbers follows the growing of the quality (e.g., relevance, importance, etc) instead of growing in less quality.

1.3.1. Q6_How do you perceive the relevance of the lecture for your performance in the subsequent semesters of the undergraduate degree?

Table 15. Perceived relevance of the lectures, in the first learning period (semester) that the content topic was lectured.

Quest. Nº	Name [line]	Variable
6	R [11]	Perceived relevance of the lecture_6

Table 16. Values of “Perceived relevance of the lectures, in the first learning period (semester) that the content topic was lectured.”

Very relevant	1	Little relevant
Between medium and very relevant	2	Between little and medium relevant
Medium relevant	3	Medium relevant
Between little and medium relevant	4	Between medium and very relevant
Little relevant	5	Very relevant

Notes: The left side of the table refers to the order presented in the questionnaire; and the right side, the reordering of the values for enabling a more fluid data analysis, based the logic of growing of the quality (e.g., relevance) instead of a decreasing of the quality.

1.3.2. Q7_How easy was for you to learn the following content-topics?

- Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.)
- 2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)
- 3D principles of form creation (e.g., solids; structures; length-width-height; modularity-patterning; formal coherence; etc)
- Personal values and skills (autonomy; self-knowledge; collaboration; communication; resilience; curiosity; confidence)
- Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)
- Texture (e.g., tactile boards; visual textures; surface of objects; etc)
- Visual (perceptive) principles: parts-totality; macro-micro; figure-ground; layering; scale; proportions; etc)

Table 17. Perceived ease to learn the contents, in the first learning period (semester) that the content topic was lectured.

Quest. Nº	Name [line]	Label
New variables based on questions related to nº7	Ecolor [12]	Perceived ease to learn: Color_7.1
	E2d [13]	Perceived ease to learn: 2D principles of form creation_7.2
	E3d [14]	Perceived ease to learn: Personal values and skills_7.3
	Epvs [15]	Perceived ease to learn: Materials and techniques_7.4
	Emt [16]	Perceived ease to learn: Materials and techniques_7.5
	Et [17]	Perceived ease to learn: Texture_7.6
	Evps [18]	Perceived ease to learn: Visual (perceptive) principles_7.7

Table 18. Values of “Perceived ease to learn the contents, in the first learning period (semester) that the content topic was lectured”.

Very easy	1	Not easy at all
Moderately easy	2	Little easy
Moderately difficult	3	Easy
Very difficult	4	Very easy
Does not apply	5	Not learned

1.3.3. Q8_During the lecture, how did you perceive the use of digital technology?

8.1_Authoring tools: for creation of content and information; communication and collaboration; learning assessment.

8.2_Search, store and socialize content tools: to find, save and share information and content, in a diversity of digital formats.

8.3_Virtual immersive tools: for experiences very similar to the real environment, for immersion in a virtual world.

8.4_Assistive technologies: for the participation and access of people with disabilities to information and content, allowing more autonomy, learning and digital inclusion.

8.5_Task management tools: for administration, organization and systematization of daily tasks, professional projects.

Table 19. Perception of the use of digital technology in the lecture, in the first learning period (semester) that the content topic was lectured.

Quest. Nº	Name [line]	Label
8	Afreq [19]	Frequency of use: Authoring tools_8.1.1
	Ahelp [20]	Helpful of use: Authoring tools_8.1.2
	Aidfreq [21]	Ideal frequency of use: Authoring tools_8.1.3
	Aad [22]	Adequacy of use: Authoring tools_8.1.4
	Sfreq [23]	Frequency of use: Search, store and socialize content tools_8.2.1
	Shelp [24]	Helpful of use: Search, store and socialize content tools_8.2.2
	Sidfreq [25]	Ideal frequency of use: Search, store and socialize content tools_8.2.3
	Sad [26]	Adequacy of use: Search, store and socialize content tools_8.2.4
	Vfreq [27]	Frequency of use: Virtual immersive tools_8.3.1
	Vhelp [28]	Helpful of use: Virtual immersive tools_8.3.2
	Vidfreq [29]	Ideal frequency of use: Virtual immersive tools_8.3.3
	Vad [30]	Adequacy of use: Virtual immersive tools_8.3.4
	ASfreq [31]	Frequency of use: Assistive technologies_8.4.1
	AShelp [32]	Helpful of use: Assistive technologies_8.4.2

	ASidfreq [33]	Ideal frequency of use: Assistive technologies_8.4.3
	ASad [34]	Adequacy of use: Assistive technologies_8.4.4
	Tfreq [35]	Frequency of use: Task management tools_8.5.1
	Thelp [36]	Helpful of use: Task management tools_8.5.2
	Tidfreq [37]	Ideal frequency of use: Task management tools_8.5.3
	Tad [38]	Adequacy of use: Task management tools_8.5.4

Table 20. Perception of the use of digital technology in the lecture, in the first learning period (semester) that the content topic was lectured.

8.(1-5).1_How often did you use them?
8.(1-5).2_How helpful were they?
8.(1-5).3_In an ideal situation, how often they should be used?
8.(1-5).4_Adequacy of use (idfreq-freq)

Table 21. Values for “Frequency of use” and “Ideal frequency of use”.

Regularly (at least, 1x per week)	1	Never
Often (at least, 1x per month)	2	Rarely, (at least, 1x per semester)
Occasionally (at least, 1x per trimester)	3	Occasionally (at least, 1x per trimester)
Rarely, (at least, 1x per semester)	4	Often (at least, 1x per month)
Never	5	Regularly (at least, 1x per week)

Table 22. Values for “Helpful of use.”

Extremely helpful	1	Not helpful at all
Very helpful	2	Slightly helpful
Moderately helpful	3	Moderately helpful
Slightly helpful	4	Very helpful
Not helpful at all	5	Extremely helpful
Does not apply	6	Not used

Table 23. Values for “Adequacy of use” (idfreq-freq).

1	Extreme lack of use	Should be extremely more used than it is	4	positive (1 to 4)
2	Very lack of use	Should be much more used than it is	3	Not adequate, should be more used, from 1 (a little more used) to 4 (much more used)
3	Lack of use	Should be more used than it is	2	
4	Some lack of use	Should be a bit more used than it is	1	
5	Adequate use	Adequate use	0	
6	Some excessive use	Should be a bit less used than it is	-1	negative (-1 to -4)
7	Excessive use	Should be less used than it is	-2	Not adequate, should be less used, from -1 (a little less used) to -4 (much less used)
8	Very excessive use	Should be very less used than it is	-3	
9	Extremely excessive use	Should be extremely less used than it is	-4	

1.4. Proficiency of immersive Virtual Reality (iVR)

The following video shows some examples of iVR for art, illustration, and design purposes. Please watch it before answering the questions.



Figure 1. A video is available in the link: https://youtu.be/W7xwk_ny9FM

1.4.1. Q9_What is your proficiency with immersive Virtual Reality (iVR) technology?

Table 24. Proficiency with immersive Virtual Reality (iVR) technology.

Quest. Nº	Name [line]	Label
9	Prof.iVR [39]	Proficiency with iVR_9

Table 25. Values for “Proficiency with immersive Virtual Reality (iVR) technology”.

Familiarised with iVR concept and had iVR experience	1	Not familiarised with iVR concept
Familiarised with iVR concept but never experienced it	2	Somewhat familiarised with iVR concept
Somewhat familiarised with iVR concept	3	Familiarised with iVR concept but never experienced it
Not familiarised with iVR concept	4	Familiarised with iVR concept and had iVR experience

1.4.2. Q10_In what area is your experience with Virtual Reality (iVR) technology?

Table 26. Areas of experience with Virtual Reality (iVR) technology.

Quest. Nº	Name [line]	Label
10	Aexp.iVR [40]	Areas of experience with iVR_10

Table 27. Options for “Areas of experience with Virtual Reality (iVR) technology”.

1	Random experiences or curiosity trial
2	Co-design and collaborative work
3	Research projects
4	Home entertainment
5	Health purposes, such as physiotherapy or psychotherapy
6	Contemplation, meditation activities
7	Virtual meetings or classes
8	Content developer
9	Teaching and learning contexts
10	Virtual visits to exhibitions or to otherwise inaccessible places
11	None

Table 28. Experience/No experience with VR.

Quest. Nº	Name [line]	Label
10.1	expNOexpivR [82]	Experience and no experience with iVR_10.1

1.5. Perception of the impact of iVR technology for teaching and learning the design fundamental

1.5.1. Q11_ How do you evaluate the following statements? The use of iVR-based tools is likely to...

- ... motivate students to the lecture.
- ... have a major contribution to attaining the objectives of the lecture.
- ... enable more focus and concentration during the tasks.
- ... allow collaborative tasks.
- ... support remotely (asynchronous and synchronous) activities.
- ... favor presential/in-class activities.
- ... support real time assessment.
- ... favor student-teacher interaction.
- ... allow creativity (imagination, spontaneity and curiosity).
- ... support self-learning and self-knowledge.
- ... support simulations of authentic real-life contexts.
- ... enable exploring different senses, other than visual (e.g., auditive, tactile, etc) and their combination.

Table 29. Expected influence of iVR on the teaching-learning process.

Quest. Nº	Name [line]	Label
11.1	liVRexp.m [41]	iVR-based tools motivate students to the lecture_11.1
11.2	liVRexp.ob [42]	iVR-based tools help attaining the objectives of the lecture_11.2
11.3	liVRexp.fc [43]	iVR-based tools enable more focus and concentration_11.3
11.4	liVRexp.col [44]	iVR-based tools allow collaborative tasks_11.4
11.5	liVRexp.r [45]	iVR-based tools support remote activities_11.5

11.6	iVRexp.pres [46]	iVR-based tools favor presential/in-class activities_11.6
11.7	iVRexp.rta [47]	iVR-based tools support real time assessment_11.7
11.8	iVRexp.st [48]	iVR-based tools favor student-teacher interaction_11.8
11.9	iVRexp.creat [49]	iVR-based tools allow creativity_11.9
11.10	iVRexp.sk [50]	iVR-based tools support self-learning and self-knowledge_11.10
11.11	iVRexp.simul [51]	iVR-based tools support simulations of authentic real-life contexts_11.11
11.12	iVRexp.sen [52]	iVR-based tools enable exploring different perceptive senses_11.12

Table 30. Values for “Expected influence of iVR on the teaching-learning process”.

strongly agree	1	Not agree
agree	2	Slightly agree
disagree	3	Agree
strongly disagree	4	Strongly agree

1.5.2. Q12_What competencies do you expect an iVR-based tool enables you to perform? For each content topic (at the left), choose one option in every four cognitive levels (i.e., actions that reflect how learning is manifested)

- Color (e.g., chromatic contrasts and harmonies; theory of color; symbology of color; etc.)
- 2D principles of form creation (e.g., modularity-patterning; laws of Gestalt; formal coherence; lettering; point-line-plane; etc)
- 3D principles of form creation (e.g., solids; structures; length-width-height; modularity-patterning; formal coherence; etc)
- Personal values and skills (autonomy; self-knowledge; collaboration; communication; resilience; curiosity; confidence)
- Materials and techniques (e.g., paper; cardboard; wood; ceramics; cutting; folding; printing)
- Texture - (e.g., tactile boards; visual textures; surface of objects; etc)

- Visual (perceptive) principles: parts-totality; macro-micro; figure-ground; layering; scale; proportions; etc)

Table 31. Expectations to use iVR for performing the LOs.

	1st level [line]	2nd level [line]	3rd level [line]	4th level [line]
Expected LO's enabled by iVR-based tool related to "color"	ExpC1L [53]	ExpC2L [54]	ExpC3L [55]	ExpC4L [56]
Quest. Nº	12.1.1L	12.1.2L	12.1.3L	12.1.4L
Expected LO's enabled by iVR-based tool related to "form 2D"	Exp2D1L [57]	Exp2D2L [58]	Exp2D3L [59]	Exp2D4L [60]
Quest. Nº	12.2.1L	12.2.2L	12.2.3L	12.2.4L
Expected LO's enabled by iVR-based tool related to "form 3D"	Exp3D1L [61]	Exp3D2L [62]	Exp3D3L [63]	Exp3D4L [64]
Quest. Nº	12.3.1L	12.3.2L	12.3.3L	12.3.4L
Expected LO's enabled by iVR-based tool related to "personal values and skills"	ExpPVS1L [65]	ExpPVS2L [66]	ExpPVS3L [67]	ExpPVS4L [68]
Quest. Nº	12.4.1L	12.4.2L	12.4.3L	12.4.4L
Expected LO's enabled by iVR-based tool related to "materials and techniques"	ExpMT1L [69]	ExpMT2L [70]	ExpMT3L [71]	ExpMT4L [72]
Quest. Nº	12.5.1L	12.5.2L	12.5.3L	12.5.4L
Expected LO's enabled by iVR-based tool related to "texture"	ExpT1L [73]	ExpT2L [74]	ExpT3L [75]	ExpT4L [76]
Quest. Nº	12.6.1L	12.6.2L	12.6.3L	12.6.4L
Expected LO's enabled by iVR-based tool related to "visual principles"	ExpVP1L [77]	ExpVP2L [78]	ExpVP3L [79]	ExpVP4L [80]
Quest. Nº	12.7.1L	12.7.2L	12.7.3L	12.7.4L

Table 32. Values (verbs) in each cognitive level.

1st level	2nd level	3rd level	4th level
Identify	Acquire habits	Analyze	Reflect/contemplate
Represent	Differentiate	Integrate	Substantiate/prove
Exercise	Present results	Criticize/judge/decide	To master
Recognize	Explore/experiment	Apply	Create/compose
None of the previous options	None of the previous options	None of the previous options	None of the previous options

Table 33. Examples of learning outcomes combining each verb to the content topic Color, which can be applied in similar manner to the other content-topics.

Cognitive level/level of understanding	Verbs per cognitive level followed by an example of a possible learning outcome using that verb.
1st level	Identify (e.g., If I use an iVR-based tool I can identify color theories)
	Represent (e.g., If I use an iVR-based tool I can represent an achromatic scale)
	Exercise (e.g., If I use an iVR-based tool I can exercise the different color scales)
	Recognize (e.g., If I use an iVR-based tool I can recognize aspects of the symbology of color)
2nd level	Acquire habits/practice (e.g., If I use an iVR-based tool I can practice the color scales)
	Differentiate (e.g., If I use an iVR-based tool I can differentiate subtle color differences)
	Present results (e.g., If I use an iVR-based tool I can present the results of a given color theory)
	Explore/Experiment (e.g., If I use an iVR-based tool I can experiment different color palettes in one composition)
3rd level	Analyze (e.g., If I use an iVR-based tool I can analyze the effect of colors in the compositions)
	Integrate (e.g., If I use an iVR-based tool I can integrate colors in the assignments)
	Criticize/judge/decide (e.g., If I use an iVR-based tool I can decide the best solution)
	Apply (e.g., If I use an iVR-based tool I can apply the symbology of color)
4th level	Reflect/contemplate (e.g., If I use an iVR-based tool I can reflect on the consequences of a color palette in a composition)
	Substantiate/prove (e.g., If I use an iVR-based tool I can prove the adequacy of a color in a composition)
	To master (e.g., If I use an iVR-based tool I can master the chromatic contrasts)
	Create/compose (e.g., If I use an iVR-based tool I can create new chromatic harmonies)

K. Descriptive statistics

1. Characterization of the sample

1.1. Age

Table 34. Age of the participants (Descriptive statistics).

	N	Minimum	Maximum	Mean	Std. Deviation
Age_1.1	58	19	28	20,45	1,547
Valid N (listwise)	58				

1.2. Gender

Table 35. Gender of the participants (Frequencies statistics).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	18	31,0	31,0	31,0
	female	40	69,0	69,0	100,0
	Total	58	100,0	100,0	

1.3. Undergraduate design degree X Higher Education institution X Country

Table 36. Participants: undergraduate design degree; HE institution; and country (Crosstabs. Case processing summary).

		Name of the Higher Education institution_3			Total
		Middle East Technical University, Turkey	Atilim University Fine Arts, Design and Architecture Faculty, Turkey	IADE - Faculdade de Design, Tecnologia e Comunicação, Portugal	
Name of the undergraduate design degree_2	Design	0	0	49	49
	Design Global	0	0	2	2
	Fashion and textile design	0	5	0	5
	Industrial design	1	1	0	2
Total		1	6	51	58

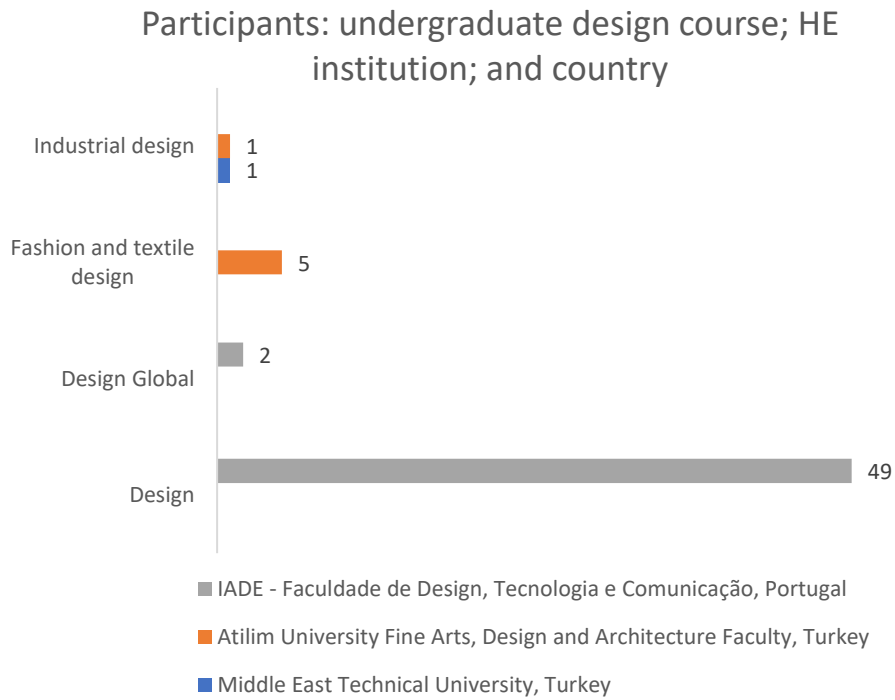


Figure 2. Perceived relevance of the lecture (Frequencies).

1.4. Perception of previous experiences related to the learning of the design fundamentals

1.4.1. Perceived relevance of the lecture

Table 37. Perceived relevance of the lecture (Explore Descriptives).

		Statistic	Std. Error
Perceived relevance of the lecture_6	Mean	3,10	,163
	95% Confidence Interval for Mean	Lower Bound	2,78
		Upper Bound	3,43
	5% Trimmed Mean	3,11	
	Median	3,00	
	Variance	1,533	
	Std. Deviation	1,238	
	Minimum	1	
	Maximum	5	
	Range	4	
	Interquartile Range	2	
	Skewness	,027	,314
	Kurtosis	-1,097	,618

Table 38. Perceived relevance of the lecture (Frequencies: Statistics).

N	Valid	58
	Missing	0
Mean		3,10
Std. Error of Mean		,163
Median		3,00
Mode		2
Std. Deviation		1,238
Variance		1,533
Range		4
Minimum		1
Maximum		5

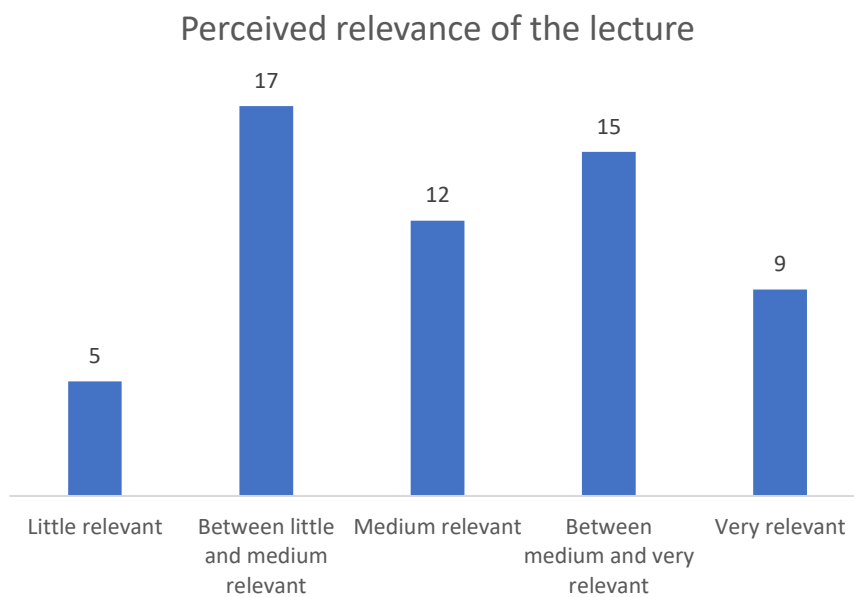


Figure 3. Perceived relevance of the lecture (Frequencies).

1.4.2. Perceived ease to learn the content-topics

Table 39. Perceived ease to learn: Color (Explore: Descriptives).

			Statistic	Std. Error
Perceived ease to learn: Color_7.1	Mean		3,12	,116
	95% Confidence Interval for Mean	Lower Bound	2,89	
		Upper Bound	3,35	
	5% Trimmed Mean		3,19	
	Median		3,00	
	Variance		,775	
	Std. Deviation		,880	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-1,042	,314
	Kurtosis		,733	,618

Table 40. Perceived ease to learn: 2D principles of form creation (Explore: Descriptives).

			Statistic	Std. Error
Perceived ease to learn: 2D principles of form creation_7.2	Mean		2,76	,099
	95% Confidence Interval for Mean	Lower Bound	2,56	
		Upper Bound	2,96	
	5% Trimmed Mean		2,79	
	Median		3,00	
	Variance		,572	
	Std. Deviation		,757	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,569	,314
	Kurtosis		,365	,618

Table 41. Perceived ease to learn: 3D principles of form creation (Explore: Descriptives).

			Statistic	Std. Error
Perceived ease to learn: 3D principles of form creation_7.3	Mean		2,53	,135
	95% Confidence Interval for Mean	Lower Bound	2,26	
		Upper Bound	2,80	
	5% Trimmed Mean		2,53	
	Median		2,00	
	Variance		1,039	
	Std. Deviation		1,020	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		,031	,316
	Kurtosis		-1,086	,623

Table 42. Perceived ease to learn: Personal values and skills (Explore: Descriptives).

			Statistic	Std. Error
Perceived ease to learn: Personal values and skills_7.4	Mean		2,83	,108
	95% Confidence Interval for Mean	Lower Bound	2,61	
		Upper Bound	3,04	
	5% Trimmed Mean		2,86	
	Median		3,00	
	Variance		,672	
	Std. Deviation		,819	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,657	,314
	Kurtosis		,267	,618

Table 43. Perceived ease to learn: Materials and techniques (Explore: Descriptives).

			Statistic	Std. Error
Perceived ease to learn: Materials and techniques_7.5	Mean		2,62	,131
	95% Confidence Interval for Mean	Lower Bound	2,36	
		Upper Bound	2,88	
	5% Trimmed Mean		2,63	
	Median		3,00	
	Variance		,944	
	Std. Deviation		,972	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,032	,322
	Kurtosis		-,971	,634

Table 44. Perceived ease to learn: Texture (Explore: Descriptives).

			Statistic	Std. Error
Perceived ease to learn: Texture_7.6	Mean		2,56	,129
	95% Confidence Interval for Mean	Lower Bound	2,30	
		Upper Bound	2,82	
	5% Trimmed Mean		2,57	
	Median		2,50	
	Variance		,805	
	Std. Deviation		,897	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		,081	,343
	Kurtosis		-,719	,674

Table 45. Perceived ease to learn: Visual (perceptive) principles (Explore: Descriptives).

		Statistic	Std. Error
Perceived ease to learn: Visual (perceptive) principles_7.7	Mean	2,79	,121
	95% Confidence Interval for	Lower Bound	2,54
	Mean	Upper Bound	3,03
	5% Trimmed Mean		2,82
	Median		3,00
	Variance		,826
	Std. Deviation		,909
	Minimum		1
	Maximum		4
	Range		3
	Interquartile Range		1
	Skewness	-,308	,319
	Kurtosis	-,648	,628

Table 46. Perceived ease to learn the content topics (Frequencies: Statistics).

		Color 7.1	2D principles of form creation 7.2	3D principles of form creation 7.3	Personal values and skills 7.4	Material s and techniqu es 7.5	Texture_ 7.6	Visual principles_ 7.7
N	Valid	58	58	57	58	55	48	56
	Missing	0	0	1	0	3	10	2
Mean		3,12	2,76	2,53	2,83	2,62	2,56	2,79
Median		3,00	3,00	2,00	3,00	3,00	2,50	3,00
Mode		3	3	2	3	2	2	3
Std. Deviation		,880	,757	1,020	,819	,972	,897	,909
Variance		,775	,572	1,039	,672	,944	,805	,826
Range		3	3	3	3	3	3	3

Perceived ease to learn the content topics

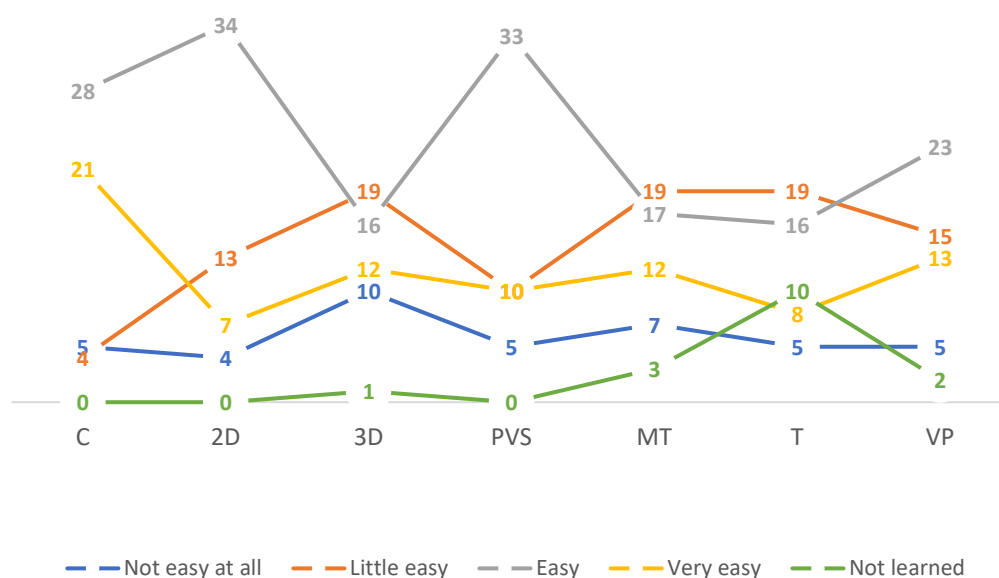


Figure 4. Perceived ease to learn the content topics (frequency).

1.5. Use of digital technology in the lectures

1.5.1. Types of technology: Frequency of use

Table 47. Authoring tools: frequency of use (Explore: Descriptives).

		Statistic	Std. Error
Frequency of use: Authoring tools_8.1.1	Mean	4,26	,129
	95% Confidence Interval for Mean	Lower Bound	4,00
		Upper Bound	4,52
	5% Trimmed Mean	4,36	
	Median	5,00	
	Variance	,967	
	Std. Deviation	,983	
	Minimum	1	
	Maximum	5	
	Range	4	
	Interquartile Range	1	
	Skewness	-1,352	,314
	Kurtosis	1,376	,618

Table 48. Search, store and socialize content tools: frequency of use (Explore: Descriptives).

			Statistic	Std. Error
Frequency of use: Search, store and socialize content tools _8.2.1	Mean		4,21	,132
	95% Confidence Interval for Mean	Lower Bound	3,94	
		Upper Bound	4,47	
	5% Trimmed Mean		4,30	
	Median		5,00	
	Variance		1,009	
	Std. Deviation		1,005	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		1	
	Skewness		-1,187	,314
	Kurtosis		,816	,618

Table 49. Virtual immersive tools: frequency of use (Explore: Descriptives).

			Statistic	Std. Error
Frequency of use: Virtual immersive tools _8.3.1	Mean		2,48	,176
	95% Confidence Interval for Mean	Lower Bound	2,13	
		Upper Bound	2,84	
	5% Trimmed Mean		2,43	
	Median		2,00	
	Variance		1,798	
	Std. Deviation		1,341	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		3	
	Skewness		,536	,314
	Kurtosis		-,919	,618

Table 50. Assistive technologies: frequency of use (Explore: Descriptives).

			Statistic	Std. Error
Frequency of use: Assistive technologies_8.4.1	Mean		2,47	,196
	95% Confidence Interval for Mean	Lower Bound	2,07	
		Upper Bound	2,86	
	5% Trimmed Mean		2,41	
	Median		2,00	
	Variance		2,218	
	Std. Deviation		1,489	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		3	
	Skewness		,432	,314
	Kurtosis		-1,336	,618

Table 51. Task management tools: frequency of use (Explore: Descriptives).

			Statistic	Std. Error
Frequency of use: Task management tools_8.5.1	Mean		3,48	,165
	95% Confidence Interval for Mean	Lower Bound	3,15	
		Upper Bound	3,81	
	5% Trimmed Mean		3,54	
	Median		4,00	
	Variance		1,587	
	Std. Deviation		1,260	
	Minimum		1	
	Maximum		5	
	Range		4	
	Interquartile Range		1	
	Skewness		-,559	,314
	Kurtosis		-,587	,618

Table 52. Types of technology: frequency of use (Frequencies statistics).

		Authoring tools_8.1.1	Search, store and socialize content tools_8.2.1	Virtual immersive tools_8.3.1	Assistive technologies_8. 4.1	Task management tools_8.5.1
N	Valid	58	58	58	58	58
	Missing	0	0	0	0	0
Mean		4,26	4,21	2,48	2,47	3,48
Median		5,00	5,00	2,00	2,00	4,00
Mode		5	5	1 ^a	1	4
Std. Deviation		,983	1,005	1,341	1,489	1,260

a. Multiple modes exist. The smallest value is shown

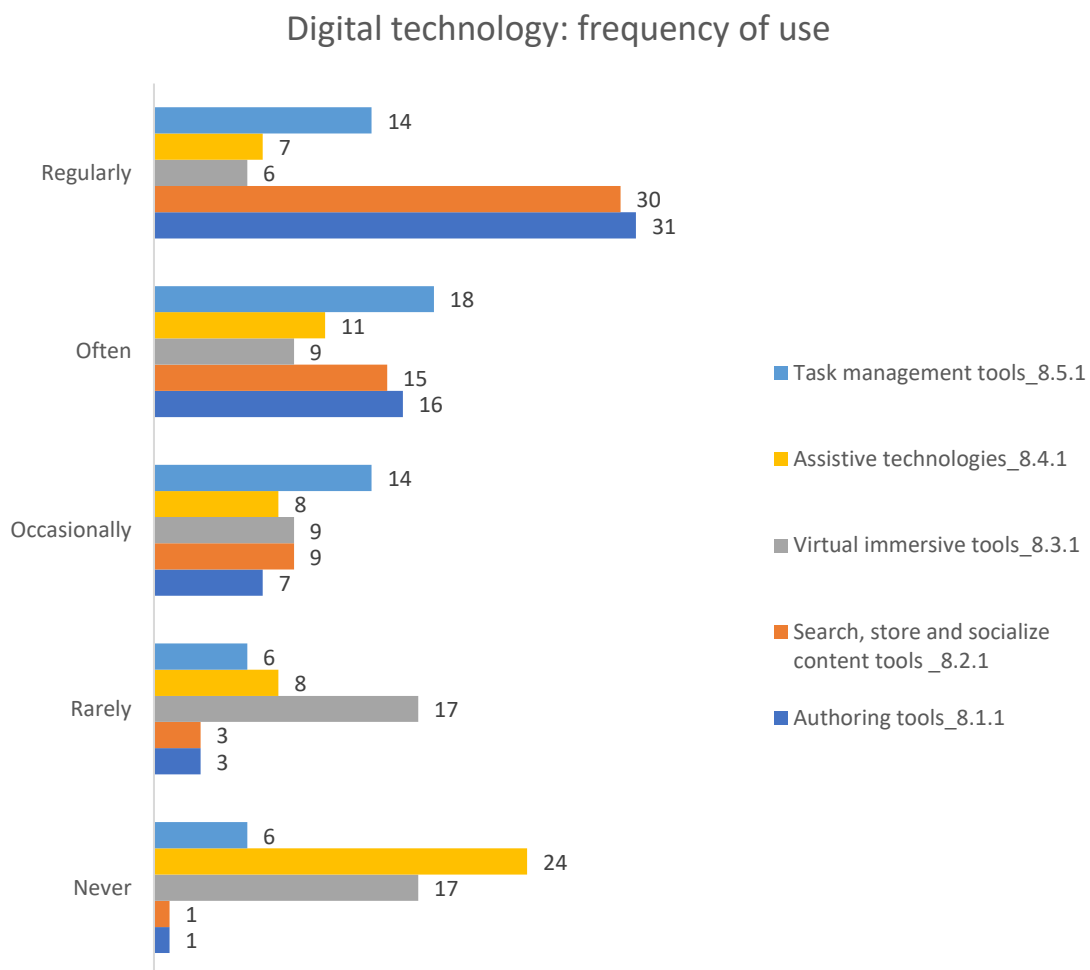


Figure 5. Types of technology: frequency of use (Frequencies).

1.5.2. Types of technology: Adequacy of use

Table 53. Authoring tools: adequacy of use (Explore: Descriptives).

			Statistic	Std. Error
Adequacy of use: Authoring tools_8.1.4	Mean		4,83	,102
	95% Confidence Interval for Mean	Lower Bound	4,62	
		Upper Bound	5,03	
	5% Trimmed Mean		4,83	
	Median		5,00	
	Variance		,601	
	Std. Deviation		,775	
	Minimum		3	
	Maximum		7	
	Range		4	
	Interquartile Range		1	
	Skewness		,079	,314
	Kurtosis		1,753	,618

Table 54. Search, store and socialize content tools: adequacy of use (Explore: Descriptives).

			Statistic	Std. Error
Adequacy of use: Search, store and socialize content tools_8.2.4	Mean		4,91	,116
	95% Confidence Interval for Mean	Lower Bound	4,68	
		Upper Bound	5,15	
	5% Trimmed Mean		4,90	
	Median		5,00	
	Variance		,782	
	Std. Deviation		,884	
	Minimum		3	
	Maximum		8	
	Range		5	
	Interquartile Range		0	
	Skewness		,330	,314
	Kurtosis		2,553	,618

Table 55. Virtual immersive tools: adequacy of use (Explore: Descriptives).

			Statistic	Std. Error
Adequacy of use: Virtual immersive tools_8.3.4	Mean		4,02	,160
	95% Confidence Interval for Mean	Lower Bound	3,70	
		Upper Bound	4,34	
	5% Trimmed Mean		4,06	
	Median		4,00	
	Variance		1,491	
	Std. Deviation		1,221	
	Minimum		1	
	Maximum		6	
	Range		5	
	Interquartile Range		2	
	Skewness		-,633	,314
	Kurtosis		-,278	,618

Table 56. Assistive technologies: adequacy of use (Explore: Descriptives).

			Statistic	Std. Error
Adequacy of use: Assistive technologies_8.4.4	Mean		3,69	,231
	95% Confidence Interval for Mean	Lower Bound	3,23	
		Upper Bound	4,15	
	5% Trimmed Mean		3,71	
	Median		5,00	
	Variance		3,095	
	Std. Deviation		1,759	
	Minimum		1	
	Maximum		6	
	Range		5	
	Interquartile Range		3	
	Skewness		-,567	,314
	Kurtosis		-1,308	,618

Table 57. Task management tools: adequacy of use (Explore: Descriptives).

		Statistic	Std. Error
Adequacy of use: Task management tools_8.5.4	Mean	4,40	,149
	95% Confidence Interval for Mean	Lower Bound	4,10
		Upper Bound	4,70
	5% Trimmed Mean		4,50
	Median		5,00
	Variance		1,296
	Std. Deviation		1,138
	Minimum		1
	Maximum		6
	Range		5
	Interquartile Range		1
	Skewness	-1,435	,314
	Kurtosis	2,180	,618

Table 58. Types of technology: adequacy of use (Frequencies statistics).

		Virtual immersive tools_8.3.4	Authoring tools_8.1.4	Search, store and socialize content tools_8.2.4	Assistive technologies_8.4.4	Task management tools_8.5.4
N	Valid	58	58	58	58	58
	Missing	0	0	0	0	0
Mean		4,02	4,83	4,91	3,69	4,40
Std. Error of Mean		,160	,102	,116	,231	,149
Median		4,00	5,00	5,00	5,00	5,00
Mode		5	5	5	5	5
Std. Deviation		1,221	,775	,884	1,759	1,138
Variance		1,491	,601	,782	3,095	1,296
Range		5	4	5	5	5
Minimum		1	3	3	1	1
Maximum		6	7	8	6	6
Sum		233	280	285	214	255

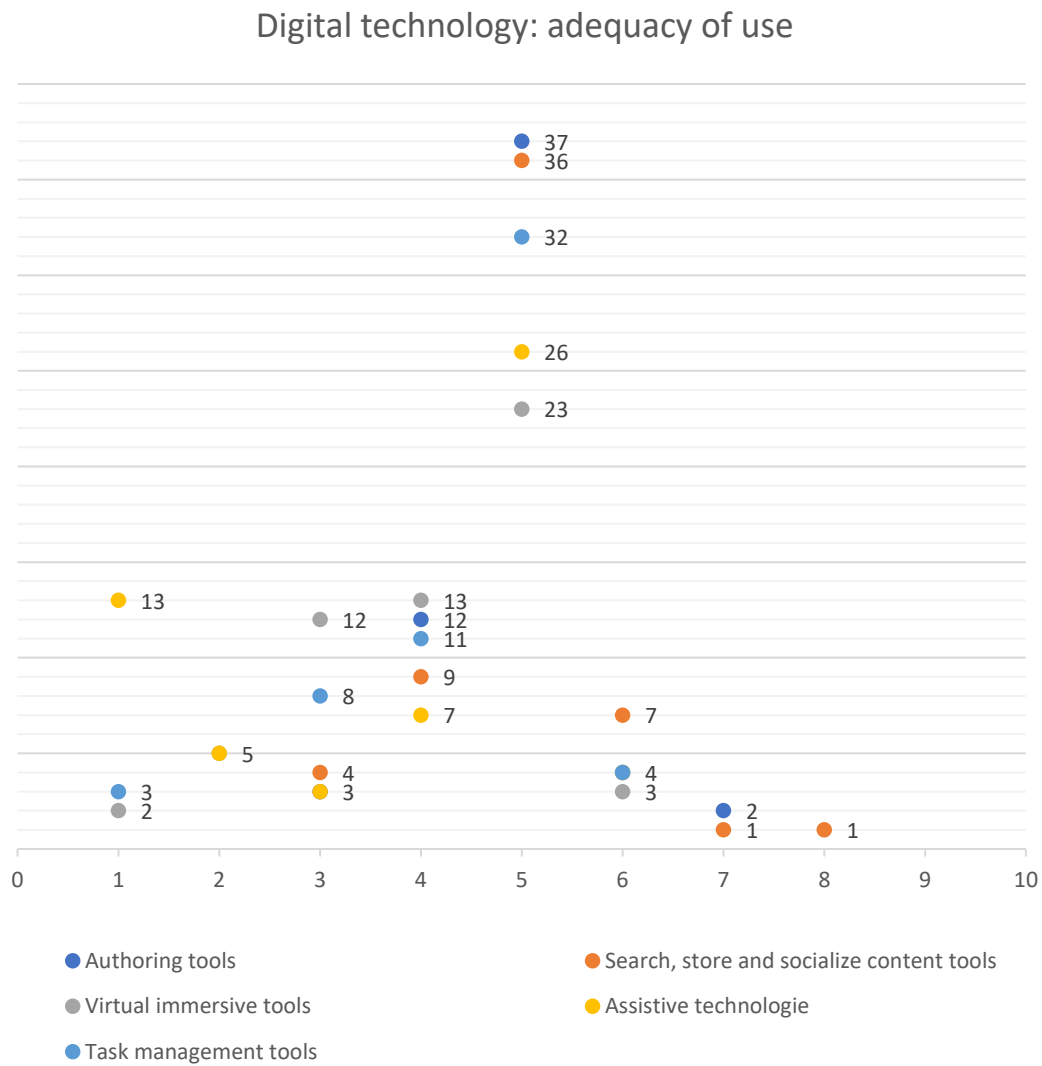


Figure 6. Types of technology: adequacy of use (Frequencies).

1.6. Expected influence of iVR in the teaching-learning process

1.6.1. Proficiency with iVR

Table 59. Proficiency with iVR (Explore: Descriptives).

		Statistic	Std. Error
Proficiency with iVR_9	Mean	2,52	,137
	95% Confidence Interval for Mean		
	Lower Bound	2,24	
	Upper Bound	2,79	
	5% Trimmed Mean	2,52	
	Median	3,00	
	Variance	1,096	
	Std. Deviation	1,047	
	Minimum	1	
	Maximum	4	
	Range	3	
	Interquartile Range	1	
	Skewness	-,047	,314
	Kurtosis	-1,158	,618

Table 60. Proficiency with iVR (Frequencies statistics).

N	Valid	58
	Missing	0
Mean		2,52
Median		3,00
Mode		3
Std. Deviation		1,047
Range		3

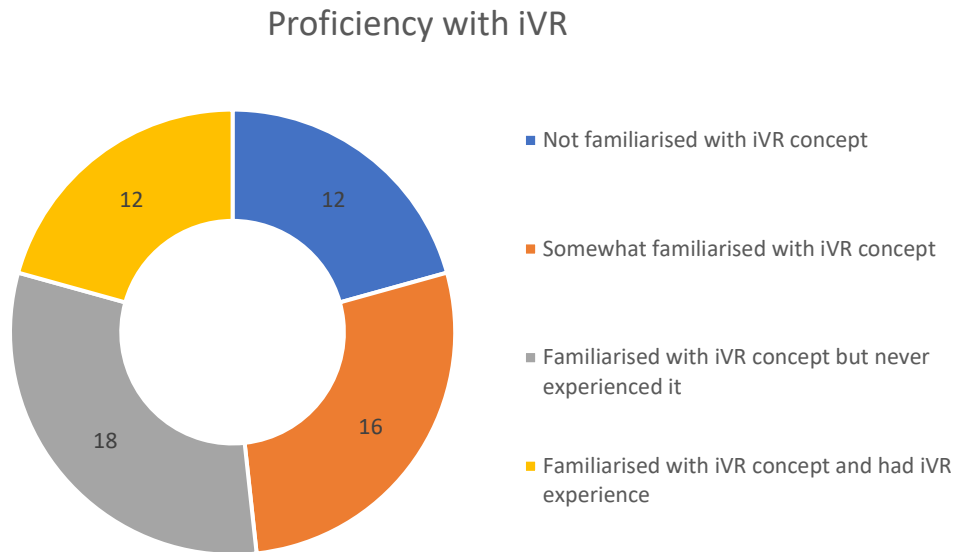


Figure 7. Proficiency with iVR (Frequencies).

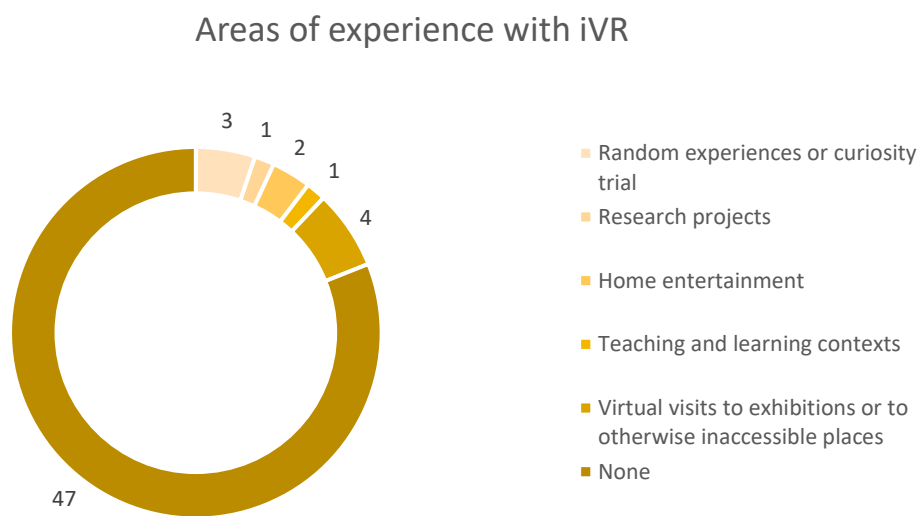


Figure 8. Areas of experience with iVR (Frequencies).

1.6.2. Expected influence of iVR in the teaching-learning process.

Table 61. Expected influence of iVR for motivating students to the lecture (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools motivate students to the lecture_11.1	Mean		3,47	,079
	95% Confidence Interval for Mean	Lower Bound	3,31	
		Upper Bound	3,62	
	5% Trimmed Mean		3,52	
	Median		4,00	
	Variance		,358	
	Std. Deviation		,599	
	Minimum		2	
	Maximum		4	
	Range		2	
	Interquartile Range		1	
	Skewness		-,625	,314
	Kurtosis		-,516	,618

Table 62. Expected influence of iVR for attaining the objectives of the lecture (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools help attaining the objectives of the lecture_11.2	Mean		3,12	,082
	95% Confidence Interval for Mean	Lower Bound	2,96	
		Upper Bound	3,28	
	5% Trimmed Mean		3,13	
	Median		3,00	
	Variance		,389	
	Std. Deviation		,623	
	Minimum		2	
	Maximum		4	
	Range		2	
	Interquartile Range		1	
	Skewness		-,084	,314
	Kurtosis		-,379	,618

Table 63. Expected influence of iVR for focus and concentration (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools enable more focus and concentration_11.3	Mean		3,09	,113
	95% Confidence Interval for Mean	Lower Bound	2,86	
		Upper Bound	3,31	
	5% Trimmed Mean		3,13	
	Median		3,00	
	Variance		,747	
	Std. Deviation		,864	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		2	
	Skewness		-,508	,314
	Kurtosis		-,672	,618

Table 64. Expected influence of iVR for collaborative tasks (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools allow collaborative tasks_11.4	Mean		3,24	,083
	95% Confidence Interval for Mean	Lower Bound	3,08	
		Upper Bound	3,41	
	5% Trimmed Mean		3,29	
	Median		3,00	
	Variance		,397	
	Std. Deviation		,630	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,668	,314
	Kurtosis		1,634	,618

Table 65. Expected influence of iVR for remote activities (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools support remote activities_11.5	Mean		3,14	,080
	95% Confidence Interval for Mean	Lower Bound	2,98	
		Upper Bound	3,30	
	5% Trimmed Mean		3,15	
	Median		3,00	
	Variance		,367	
	Std. Deviation		,605	
	Minimum		2	
	Maximum		4	
	Range		2	
	Interquartile Range		1	
	Skewness		-,065	,314
	Kurtosis		-,259	,618

Table 66. Expected influence of iVR for presental/in-class activities (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools favor presental/in-class activities_11.6	Mean		3,24	,102
	95% Confidence Interval for Mean	Lower Bound	3,04	
		Upper Bound	3,45	
	5% Trimmed Mean		3,31	
	Median		3,00	
	Variance		,607	
	Std. Deviation		,779	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,917	,314
	Kurtosis		,680	,618

Table 67. Expected influence of iVR for real time assessment (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools support real time assessment_11.7	Mean		3,21	,104
	95% Confidence Interval for Mean	Lower Bound	3,00	
		Upper Bound	3,41	
	5% Trimmed Mean		3,27	
	Median		3,00	
	Variance		,623	
	Std. Deviation		,789	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,833	,314
	Kurtosis		,422	,618

Table 68. Expected influence of iVR for student-teacher interaction (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools favor student-teacher interaction_11.8	Mean		3,09	,113
	95% Confidence Interval for Mean	Lower Bound	2,86	
		Upper Bound	3,31	
	5% Trimmed Mean		3,15	
	Median		3,00	
	Variance		,747	
	Std. Deviation		,864	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,677	,314
	Kurtosis		-,180	,618

Table 69. Expected influence of iVR for creativity (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools allow creativity_11.9	Mean		3,59	,089
	95% Confidence Interval for Mean	Lower Bound	3,41	
		Upper Bound	3,76	
	5% Trimmed Mean		3,67	
	Median		4,00	
	Variance		,457	
	Std. Deviation		,676	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-1,735	,314
	Kurtosis		3,046	,618

Table 70. Expected influence of iVR for self-learning and self-knowledge (Explore: Descriptives).

			Statistic	Std. Error
liVR-based tools to support self-learning and self- knowledge_11.10	Mean		3,26	,100
	95% Confidence Interval for Mean	Lower Bound	3,06	
		Upper Bound	3,46	
	5% Trimmed Mean		3,33	
	Median		3,00	
	Variance		,581	
	Std. Deviation		,762	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,972	,314
	Kurtosis		,990	,618

Table 71. Expected influence of iVR for simulating authentic real life contexts (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools support simulations of authentic real-life contexts_11.11	Mean		3,43	,086
	95% Confidence Interval for Mean	Lower Bound	3,26	
		Upper Bound	3,60	
	5% Trimmed Mean		3,50	
	Median		3,50	
	Variance		,425	
	Std. Deviation		,652	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-1,113	,314
	Kurtosis		1,935	,618

Table 72. Expected influence of iVR for exploring different perceptive senses (Explore: Descriptives).

			Statistic	Std. Error
iVR-based tools enable exploring different perceptive senses_11.12	Mean		3,43	,102
	95% Confidence Interval for Mean	Lower Bound	3,23	
		Upper Bound	3,63	
	5% Trimmed Mean		3,52	
	Median		4,00	
	Variance		,600	
	Std. Deviation		,775	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-1,402	,314
	Kurtosis		1,742	,618

Table 73. Expected influence of iVR for the teaching-learning process - variables 1 to 6 (Frequencies statistics).

		motivate students to the lecture_11.1	attaining the objectives of the lecture_11.2	focus and concentration _11.3	collabor ative tasks_1 1.4	remote activities_ 11.5	presental/i n-class activities_ 11.6
N	Valid	58	58	58	58	58	58
	Missing	0	0	0	0	0	0
Mean		3,47	3,12	3,09	3,24	3,14	3,24
Std. Error of Mean		,079	,082	,113	,083	,080	,102
Median		4,00	3,00	3,00	3,00	3,00	3,00
Mode		4	3	4	3	3	3
Std. Deviation		,599	,623	,864	,630	,605	,779
Variance		,358	,389	,747	,397	,367	,607
Range		2	2	3	3	2	3
Minimum		2	2	1	1	2	1
Maximum		4	4	4	4	4	4
Sum		201	181	179	188	182	188

Table 74. Expected influence of iVR for the teaching-learning process - variables 7 to 12 (Frequencies statistics).

		real time assessment _11.7	student- teacher interaction _11.8	creativity_ 11.9	self- learning and self- knowledge _11.10	simulations of authentic real-life contexts_11. 11	exploring different perceptive senses_11. 12
N	Valid	58	58	58	58	58	58
	Missing	0	0	0	0	0	0
Mean		3,21	3,09	3,59	3,26	3,43	3,43
Std. Error of Mean		,104	,113	,089	,100	,086	,102
Median		3,00	3,00	4,00	3,00	3,50	4,00
Mode		3	3	4	3	4	4
Std. Deviation		,789	,864	,676	,762	,652	,775
Variance		,623	,747	,457	,581	,425	,600
Range		3	3	3	3	3	3
Minimum		1	1	1	1	1	1
Maximum		4	4	4	4	4	4
Sum		186	179	208	189	199	199

Perception of iVR contribution for the following aspects of the teaching-learning process

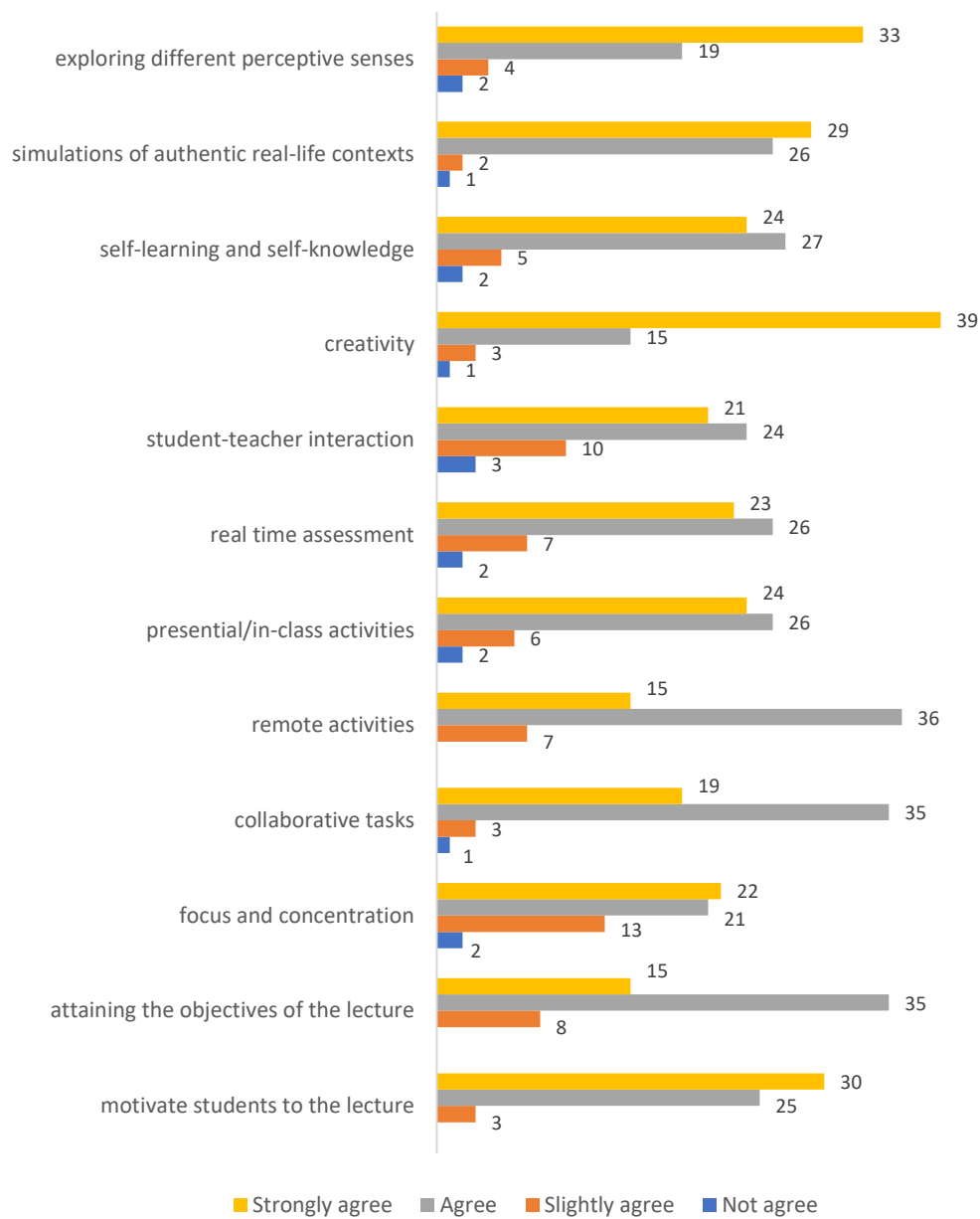


Figure 9. Expected influence of iVR for the teaching-learning process (Frequencies).

1.6.3. Expected LO's enabled by iVR-based tools.

Expectations to perform the content topics, in the 1st level of understanding

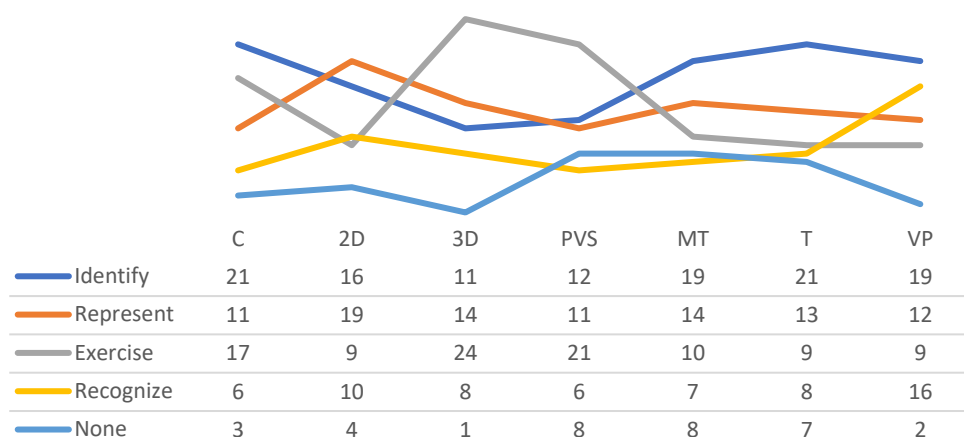


Figure 10. Frequency of verbs from the 1st level of understanding, per content-topic (Frequencies).

Expectations to perform the content topics, in the 2nd level of understanding

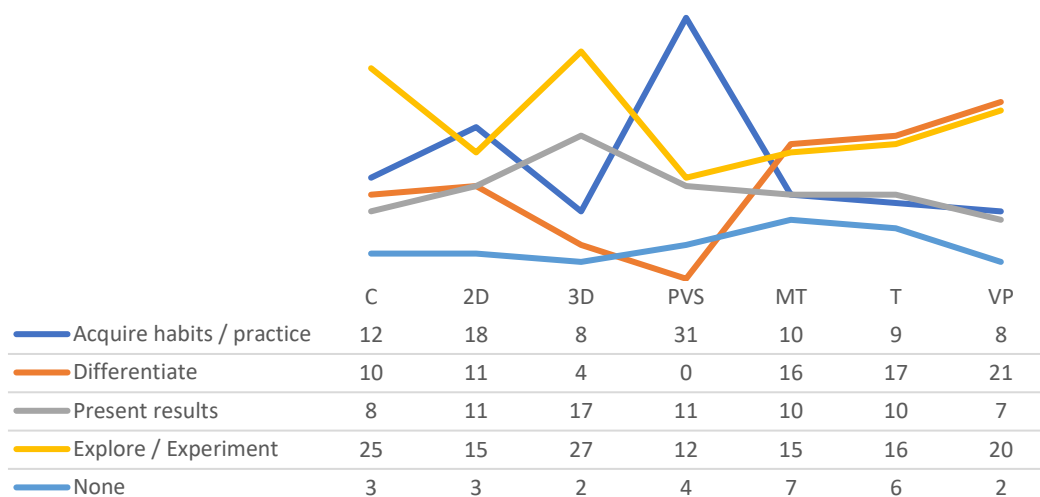


Figure 11. Frequency of verbs from the 2nd level of understanding, per content-topic (Frequencies).

Expectations to perform the content topics, in the 3rd level of understanding

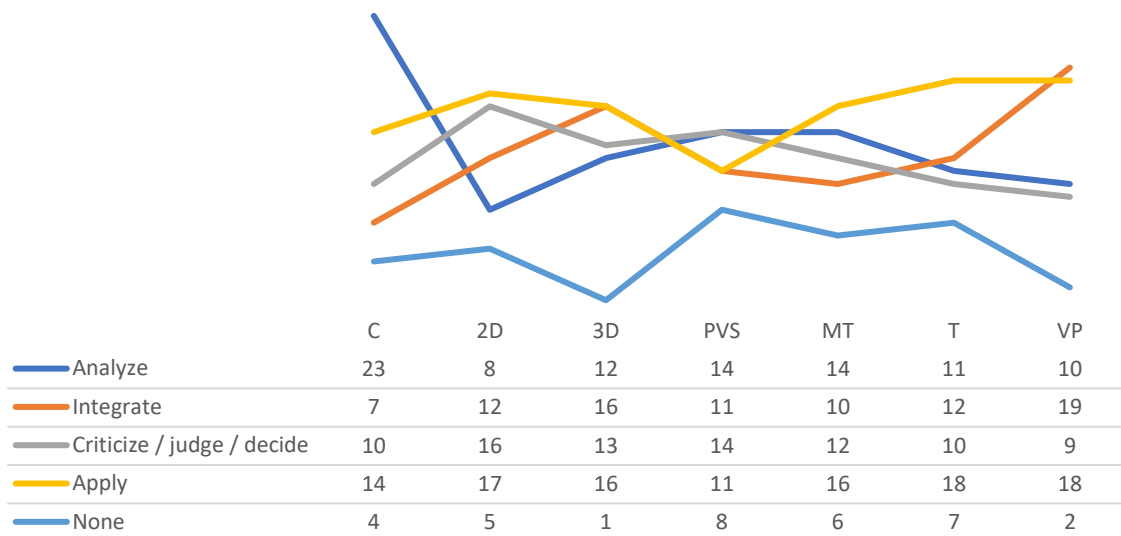


Figure 12. Frequency of verbs from the 3rd level of understanding, per content-topic (Frequencies).

Expectations to perform the content topics, in the 4th level of understanding

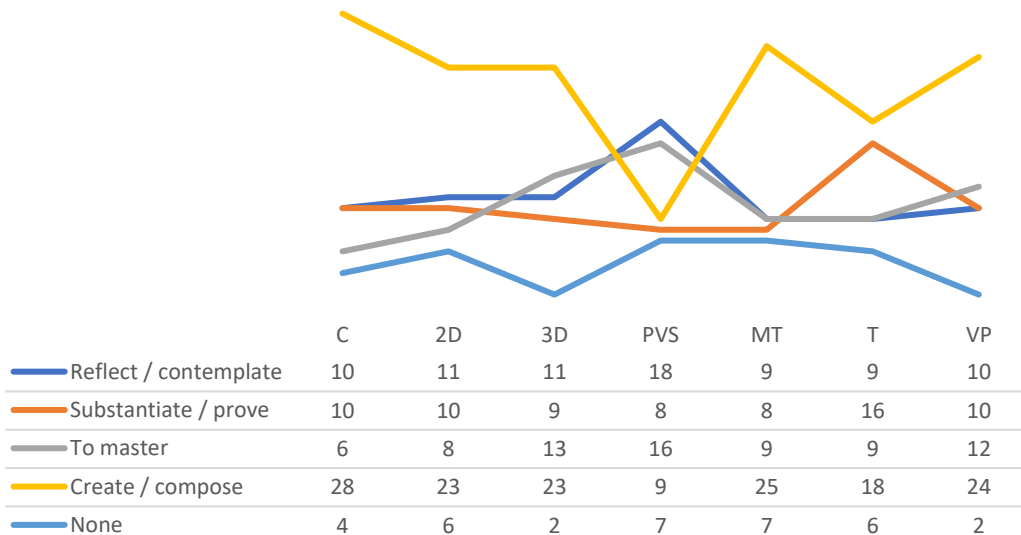


Figure 13. Frequency of verbs from the 4th level of understanding, per content-topic (Frequencies).

Table 75. Expected LOs to be performed by iVR-based tools, related to Color (Frequencies statistics).

		Color, in the 1 st level _12.1.1L	Color, in the 2 nd level _12.1.2L	Color, in the 3 rd level _12.1.3L	Color, in the 4 th level _12.1.4L
N	Valid	58	58	58	58
	Missing	0	0	0	0
Mean		2,29	2,95	2,47	3,10
Median		2,00	3,00	2,00	4,00
Mode		1	4	1	4
Std. Deviation		1,214	1,290	1,404	1,280

Table 76. Expected LOs to be performed by iVR-based tools, related to 2D principles of form creation (Frequencies statistics).

		Form 2D, in the 1 st level _12.2.1L	Form 2D, in the 2 nd level _12.2.2L	Form 2D, in the 3 rd level _12.2.3L	Form 2D, in the 4 th level _12.2.4L
N	Valid	58	58	58	58
	Missing	0	0	0	0
Mean		2,43	2,55	2,98	3,05
Median		2,00	2,50	3,00	3,50
Mode		2	1	4	4
Std. Deviation		1,258	1,314	1,192	1,330

Table 77. Expected LOs to be performed by iVR-based tools, related to 3D principles of form creation (Frequencies statistics).

		Form 3D, in the 1 st level _12.3.1L	Form 3D, in the 2 nd level _12.3.2L	Form 3D, in the 3 rd level _12.3.3L	Form 3D, in the 4 th level _12.3.4L
N	Valid	58	58	58	58
	Missing	0	0	0	0
Mean		2,55	3,19	2,62	2,93
Median		3,00	3,50	3,00	3,00
Mode		3	4	2 ^a	4
Std. Deviation		1,012	1,100	1,152	1,212

a. Multiple modes exist. The smallest value is shown

Table 78. Expected LOs to be performed by iVR-based tools, related to Personal values and skills (Frequencies statistics).

		Personal values and skills, in the 1 st level _12.4.1L	Personal values and skills, in the 2 nd level _12.4.2L	Personal values and skills, in the 3 rd level _12.4.3L	Personal values and skills, in the 4 th level _12.4.4L
N	Valid	58	58	58	58
	Missing	0	0	0	0
Mean		2,78	2,28	2,79	2,64
Median		3,00	1,00	3,00	3,00
Mode		3	1	1 ^a	1
Std. Deviation		1,285	1,461	1,373	1,385

a. Multiple modes exist. The smallest value is shown

Table 79. Expected LOs to be performed by iVR-based tools, related to Materials and techniques (Frequencies statistics).

		Materials and techniques, in the 1st level _12.5.1L	Materials and techniques, in the 2nd level _12.5.2L	Materials and techniques, in the 3rd level _12.5.3L	Materials and techniques, in the 4th level _12.5.4L
N	Valid	58	58	58	58
	Missing	0	0	0	0
Mean		2,50	2,88	2,83	3,22
Median		2,00	3,00	3,00	4,00
Mode		1	2	4	4
Std. Deviation		1,417	1,312	1,353	1,285

Table 80. Expected LOs to be performed by iVR-based tools, related to Texture (Frequencies statistics).

		Texture, in the 1st level _12.6.1L	Texture, in the 2nd level _12.6.2L	Texture, in the 3rd level _12.6.3L	Texture, in the 4th level _12.6.4L
N	Valid	58	58	58	58
	Missing	0	0	0	0
Mean		2,43	2,88	2,97	2,93
Median		2,00	3,00	3,00	3,00
Mode		1	2	4	4
Std. Deviation		1,416	1,272	1,337	1,282

Table 81. Expected LOs to be performed by iVR-based tools, related to Visual principles (Frequencies statistics).

		Visual principles, in the 1st level 12.7.1L	Visual principles, in the 2nd level 12.7.2L	Visual principles, in the 3rd level 12.7.3L	Visual principles, in the 4th level 12.7.4L
N	Valid	58	58	58	58
	Missing	0	0	0	0
Mean		2,48	2,78	2,71	2,97
Median		2,00	2,50	2,50	3,00
Mode		1	2	2	4
Std. Deviation		1,301	1,170	1,185	1,199

L. Dissemination

L1

Neves, A. G., & Duarte, E. (2015). Using Virtual Environments in Basic Design Education. In E. Duarte, C. Duarte, & F. Carvalho Rodrigues (Eds.), *Senses & Sensibility'15: Design as a Trade Proceedings of the UNIDCOM/IADE 8th International Conference* (pp. 273–280). Lisboa, Portugal: IADE -- Creative University / Edições IADE.
https://www.unidcom-iade.pt/wp-content/uploads/2018/07/Proceedings_SS15.pdf

L2

Neves, A. G., & Duarte, E. (2016). Using Virtual Environments in Basic Design Education. *The Radical Designist* (Senses & Sensibility'15 ThRAD Special Issue).
http://www.iade.pt/unidcom/radicaldesignist/wp-content/uploads/2016/02/ThRad-SS15_ANeves-EDuarte.pdf

L3

Neves, A.G., Duarte, E. & Dias, Diana (2016). Basic Design meets Virtual Reality: A tentative methodology. Em *Design Doctoral Conference Proceedings* (pp. 104-111). Lisboa, Portugal: IADE -Creative University / Edições IADE. <http://unidcom.iade.pt/ddc16/wp-content/uploads/2016/07/Proceedings-e-Book.pdf>

L4

Neves, A. G., Niemeyer, L., Duarte, E., Dias, D., Ayanoğlu, H., Teixeira, L., ... Martins, F. (2016). Learning Basic Design with Virtual Reality: A methodological approach. Em *EDULEARN16 Proceedings, 8th International Conference on Education and New Learning Technologies, July 4th-6th, 2016* – Barcelona, Spain (pp. 5394-5402). doi: [10.21125/edulearn.2016.2283](https://doi.org/10.21125/edulearn.2016.2283)

L5

Neves, A.G., Duarte, E. & Dias, Diana (July, 2016). Basic Design meets Virtual Reality: A tentative methodology. Poster presented at Encontro Ciência 2016, FCT - Fundação para a Ciência e Tecnologia, Centro de Congressos de Lisboa. <http://www.ciencia2016.pt/img/posters/392.pdf>

L6

Neves, A.G., Duarte, E., Dias, D. & Saraiva, M. (2017). The impact of a Virtual Reality-based tool on teaching and learning Basic Design: Early perceptions. Em *Design Doctoral Conference '17: TRANScendency, Proceedings of the DDC 4th Conference* (pp. 167-174). Lisboa, Portugal: IADE -Creative University / Edições IADE. <https://www.unidcom-iade.pt/wp-content/uploads/2018/09/DDC17-Proceedings.pdf>

L7

Neves, A.G., Duarte, E. & Dias, D. (2018). Basic Design at IADE: Drawing the line. Em E. Duarte (Ed.), *Design Doctoral Conference '18: TRANSGression. Proceedings of the DDC 5th Conference* (pp. 137–144). Universidade Europeia, IADE, Lisboa: Edições IADE. <https://www.unidcom-iade.pt/wp-content/uploads/2018/11/DDC-18-web.pdf>

L8

Neves, A. G., Dias, D., & Duarte, E. (2018). As Basic Design promotes the design learning: Featuring the Portuguese Higher Education setting. Em L. Gómez Chova, A. López Martínez, & I. Candel Torres (Eds.), *ICERI2018 Proceedings 11th annual International Conference of Education, Research and Innovation* (pp. 7663–7671). Seville, Spain: IATED Academy. doi: [10.21125/iceri.2018.0376](https://doi.org/10.21125/iceri.2018.0376)

L9

Neves, A. G., Dias, D., Duarte, E. & Ramalho, J. (2019). Back to the Basic of Basic Design: The Portuguese Scenario. Em L. Gómez Chova, A. López Martínez, & I. Candel Torres (Eds.), *ICERI2019, 12th annual International Conference of Education, Research and Innovation* (pp. 416–425). Seville, Spain: IATED Academy. doi: [10.21125/iceri.2019.0139](https://doi.org/10.21125/iceri.2019.0139)

L10

Neves, A. G., Duarte, E. & Dias, D. (2019). Micro influence of Learning Outcomes in Basic Design. Em E. Duarte & C. Rosa (Eds.), *Proceedings of the UNIDCOM 10th International Conference* (pp. 26-36). Edições IADE, Universidade Europeia. http://senses2019.unidcom-iade.pt/wp-content/uploads/2020/12/Proceedings-of-the-10th-International-Conference-SensesSensibility-2019-Lost-in-Glocalization-final-version_medium.pdf

L11

Neves, A.G., Duarte, E. & Dias, D. (2019). Traçando o percurso do Design Básico no IADE. *ErgodesignHCI*, 7(1), 66-81. doi: [10.22570/ergodesignhci.v7i1.1006](https://doi.org/10.22570/ergodesignhci.v7i1.1006)

L12

Neves, A., Ayanoglu, H., Goncalves, E., Dias, D., Duarte, E. (2022). Anticipating the Impact of Virtual Reality for Learning the Design Fundamentals: Students' Perceptions and Perspectives. In: Daniel Raposo, Nuno Martins and Daniel Brandão (eds) *Human Dynamics and Design for the Development of Contemporary Societies*. AHFE (2022) International Conference. AHFE Open Access, vol 25. AHFE International, USA. <http://doi.org/10.54941/ahfe1001404>

Using Virtual Environments in Basic Design Education

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ABSTRACT

The aim of this paper is to present a reflection about the potentiality and interest of Virtual Reality (VR) for innovation in the Basic Design education. Basic Design is about affording meaningful learning experiences to the newly arrived design students while introducing the design fundamentals. Without approaching real design problems, but abstract phenomena creation, Basic Design allows unique opportunity for self-expression and discovery. At a present course named 3D Design Lab, different construction principles provide combinatory training for generation and transformation of surfaces/patterns, volumes and spaces, according to the transformative geometry. Abstract forms manually crafted at hand scale foster a methodology for structure complexity while developing an aesthetic-projective attitude. In this context, several challenges faced by the students, such as bonding with the abstract forms; imagining different possible applications for them in the real world; and others, can be overcome within the alliance with VR. This technology is also known for promoting a sense of presence that positively affects the designer in the creative process, improve spatial visualization and, in certain conditions, enhance students learning outcomes. As discussed further, VR might impact positively the teaching and learning experiences at the course, and hence, Basic Design. Consequently, we will present the origins, utility and main theoretical concepts of Basic Design and 3D Design Lab, as well as introduce VR, its main advantages and inconveniences. Finally, possible ways of using VR in Basic Design education are advanced, from a conceptual point of view, hoping to motivate the research community for further study this possibility.

Keywords: Basic Design; 3D Design Lab; Virtual Reality (VR) and Virtual Environments (VEs).

INTRODUCTION

Given the pressing social challenges and the profound changes required in all areas of activity, the designer, creator of interfaces that mediate everyday action, is increasingly requested. Recommendations were made to improve design literacy in Europe (EDLB, 2012) providing every citizen with capabilities to transform tangible and/or intangible objects in each sector of life. Design is also known as being part of a set of senses that all individuals need to develop to overcome the conceptual age, along with Story, Symphony, Empathy, Play and Meaning (Pink, 2006).

Increasingly sooner familiar with the new digital technologies, the XXI century designers print a changing point into current teaching methodologies. The irreversibility and intensification of this phenomenon have driven the practice and evaluation of new learning environments and teaching methods. Also design education faces new challenges and opportunities, delivering new pedagogical approaches (Gu, Gul, & Williams, 2010).

Basic Design, however, remains an unexplored field regarding the use and impact of new technologies in the teaching-learning process, specifically, Virtual Reality (VR), setting a venue for research. This exploratory study presents some evidences for eventual advantages and inconveniences of that partnership, while considering the case of a present course, 3D Design Lab. Rooted in Basic Design education, the discipline reaffirms the adequacy of the referred pedagogy in the present and future of design education, where the contribute of VR technology is a possible near scenario. The validation of this statement is the main goal of a research project

conducted as part of a doctoral program that will provide possible means for assessing the impact of the VR technology: in overcoming some difficulties expressed by the first year design students under the present conditions; in the performance differentials and/or lead times; in the level of involvement/engagement in the task; and in the overall quality of user experience (UX).

BASIC DESIGN EDUCATION

At university design education programs, Basic Design is still a very important component (Boucharenc, 2006, p. 18). It refers to the teaching and learning of design fundamentals, or the Principles of Two- and Three-dimensional Design (Boucharenc, 2006, p. 1). Other authors prefer the term Design Patterns, as Bonsiepe (2007, p. 34), thereby overcoming the lack of consensus on the most widespread expression: Basic Design. We refer to the propedeutic training of projective disciplines, disseminated from the experience of the Bauhaus School (1919-33). Decisive moments in its evolution were also those perpetrated by Moholy-Nagy and Chermayeff, at the New Bauhaus, in Chicago (1937-55), and subsequently, by Max Bill, Otl Aicher and Tomás Maldonado, at Hochschule für Gestaltung, in Ulm (1953-68).

Basic Design, as it is more commonly known, is the pedagogical model invented in Bauhaus to introduce students in the design fundamentals in a rational way whilst linking the related knowledge, attitudes and skills derived from the study of Basic Design to the pedagogy of design practice (Boucharenc, 2006, p. 18). The journey develops more an attitude than a profession, built on the dichotomic pedagogical principle "intuition and method" or "subjective experience and objective recognition" (Droste, 1992, p. 25). Basic Design education is actually considered the effort of expressing the abilities and power of creativity in aesthetic level and transfer of thinking, emotions, and impressions of a person (Besgen, Kuloglu, & Fathalizadehalemdari, 2015).

Some characteristic of that initial formative period of the designer are the aesthetic and formal exercises, exploration of color, composition and texture, in order to train the sensitivity for the aesthetical-projectual phenomenon, and where the technical and physical factors of the materials, ergonomics, costs, manufacturing processes and even the function, are not considered (Bonsiepe, 2012, p. 74).

Design competencies are needed in a varied of fields and professions. According to the pedagogy spread by Moholy-Nagy, they should be developed through activities aimed at the ability to express the design elements (line, shape, color, space, movement, texture, volume) in various media, starting with tangible two-dimensional and three-dimensional (pen, pencil, paper, clay, wood); and then, intangible (light, space and sound). These explorations required the same kind of interaction with the world, the same perceptive-retinal-action used in everyday life. Findeli declares Basic Design the best pedagogic tool for developing visual intelligence in the present century. That skill allows the understanding and transformation of the invisible relations between the system's elements, in all its complexity (Findeli, 2001, p. 14).

Also Marcolli's pedagogy (1971), based on the perceptive types of E. Bullough, relegates to the current era a proposal for developing the visual perception for project activity in multiple fields of human action, including design. Such development takes place through four successive fields/spaces: geometric-intuitive; gestalt; topological; and phenomenological. They are implemented by the transformational geometry: Euclidean; affine and projective; topological; and set theory. Each field is, in turn, addressed according to its structure; the composition of objects; object-field interaction; and finally, tension and movement. The scientific literature is silent regarding Marcolli's projectual pedagogy, a fact which may be due either to the unfamiliar language, as the high level of theoretical abstraction (Federle, 2009, p. 22).

Knauer's recent approach to the principles and methodology of design, called Transformations (2008) is a great opportunity for clarifying the transformational processes constitutive of Basic Design pedagogy. According to the author, practicing the true nature of design, the constant combinatorial of elements (bar, surface and body), with the leading of aesthetics through abstract forms and a disinterest for function, may be introducing the individual to a design language. That language is developed by the individual's inner force of exploration and expression while mastering a medium. Deepening and amplifying the experiences from one medium empowers the co-generation of form and designers as integrators, as established in Moholy-Nagy's pedagogy. He envisioned, through the one medium manual-perceptive intensive training and mastery, the capacity to understand/intuit the invisible interactions in every phenomenon of the world (Findeli, 1990).

Looking in depth Knauer's "Transformations", basis structures consist of formal processes that the imagination's images can developed via not-yet-fixed structures that have not yet been to a conclusion, more easily and with fewer limitations, leading to surprising possibilities for design and reformulating (Knauer, 2008, p. vi). Accordingly, basis structure consists of a methodologic binding preparation for the form-object complexes. Relating the abstract forms/basis/signifier (form empty of content) to semiotically finished objects citations/function/signified (form related to content), is the process by which the author refers to "assigning cita-

tions to basis". Knauer argues, in this sense, that the space of aesthetic cannot be expanded without fictional, emotional and sensory values, requiring for citations, possibilities for its semantic determination. Consequently, "assigning citations to basis" extends imagination by stimulating and motivating, in an intrinsic way, the search for a vocabulary, a morphological collection.

There is also a different approach to the introductory design course, more commonly used in architectural education, Virtual Design Studios (VDS). It address a rubric called problem-based learning – PBL, also found in other disciplines such as medicine, engineering and mathematics, among others, and it is largely focused on the idea of presenting students with a real design problem, for exploring solutions, experimenting failure, success and frustration along the way (Kvan, 2001). At 3D Design Lab, as in Basic Design education, there are no real problems to be addressed, but opportunities for incorporating, by doing, the principles that underlie the creative process embedded in the prospective act, that is, project.

EXTENDING BASIC DESIGN TRADITION AT 3D DESIGN LAB

Implemented internationally, Basic Design pedagogy has been adapted to the present times (Cetinkaya, 2014). Grounded on the Basic Design pedagogy, the methodology currently adopted in Laboratório de Design 3D (3D Design Lab), was revised and updated by Fernandes (2011). With a broad frame of reference, 3D Design Lab stresses the Italian influence of Bruno Munari (1995; 1979), Attilio Marcolli (1998; 1991) and Tomas Maldonado (2012; 1981), since the foundation of IADE institute, at 1969, pioneering design teaching in Portugal. Recent school options for the discipline align with the theory-methodology of Gui Bonsiepe (2012; 1999; 1992) and the proposals of Roland Knauer's transformations (2008), in convergence with Steadman's (2008) latest compositional techniques, closely relating the nature and human action, (Fernandes, 2013).

The course is taught at an University Institute, IADE-U, to the first year design students, also known as emergent adults, individuals between the ages of 18 and 24 that are living ages of: identity explorations; instability; self-focused; feeling in-between, in transition, neither adolescent nor adult; and an unparalleled opportunity to transform their lives (Arnett, 2004, p. 8).

The structure of the course

3D Design Lab corresponds to a cross propedeutic training to the three main project areas: visual; industrial; and environments. It aims the incorporation of an investigation method for generating complex systems in parts-totalities-parts, by recursively applying trial and error while provide student engagement in creation / construction of three-dimensional, hand scale, abstract forms, mainly using the hands. The perceptive-retinal-manipulative acts aim the dynamic and transformative nature of space-3D shapes, encourages the release of the mind of pre-established phenomena, and the discovery and reinvention of reality and the individual. Functional aspects of the objects are not taken in consideration, as well as most components of a design project. Are also excluded some of the elements of design usually considered in a Basic Design course, like color and texture. The course focus on developing a sensitivity to the technological and aesthetic phenomena and projetual ability, (Bonsiepe, 2012, p. 77) over the incorporation of design patterns: field structure; reference mark; elementary part; elementary motif; combinatory; modularity; patterning; symmetry / asymmetry; formal coherence; structural consistency; systemic; complexity; simplicity; maximum diversity with the minimum repertoire; among others. These concepts are repeated throughout the three exercises, moments that reveal the influence of the four perceptive fields defined at Marcolli's projetual pedagogy (1971; 1978).

The exercises at 3D Design Lab consist of activities triggered by minimum action programs, of departure (Fernandes, 2011). Each sequence of actions will conform the object in which it is clear, in a "before and after", the emerged impasses during the process, and the overcoming those difficulties. The regular comments and criticisms to the students work are decisive for the adequate change, and therefore, an essential dialogue for learning and development. In a close orientation with each student, the teacher uses whatever examples and explanations he/she considers adequate for the overcoming the impasses. This unblocking can be considered an important pedagogic instrument, making use of verbally transmitted cues, resembling Knauer's "citations" (2008). The principles and concepts are also introduced in the dialogue with students about what is being done rather than being previously exposed. Also, no visual examples are provided, avoiding the natural tendency of novices to rush to obvious results, frequently objects semiotically recognized from the daily life, a fact also reported by Munari (1995, 22). Breaking that attitude with abstract examples is also a common strategy for developing a proper understanding of the creation and transformation process, traditionally used at Basic Design education. According Fernandes methodology, no specific competence is required for the exercises, allowing any supposed unprepared student to overcome difficulties, as they arrive, closely supported by the teach-

er's feedback. Incorporating the configuration process starts with an operative knowledge and directs itself, through an aesthetic feeling, to a reflective knowledge materialized in a totality/configuration/object.

The traditional learning by doing process is perfectly aligned to Knauer's operative aesthetic (2008, p. vi), where the search of the form is leaded, not by the function of any semiotically finished object, but by a constantly increasing of aesthetics, on an abstract form empty of content. In that sense, an increasing growth of complexity within the 3 moments/exercises is provided by: the application of successive levels of perception of space suggested by Marcolli (1998); the approaching of 2D before 3D (Bonsiepe, 1992, 161; Wong, 1995); and the creation from parts to totalities, in the first and second exercises, to the last one, where the totality of the form is first explored and then, the methodological process determines its constitutive elements. The evaluation of the exercises reflects this increasing of complexity, each one assessed in three categories of competences, with precedence: technique, analytic and aesthetic.

An engaging component is the reaching of the quality in the visual effects, when recognized by the student's themselves and their peers, referring them as interesting, beautiful, and so on. The judgment and criticism of own work and the others is rooted on technical quality and brought by an intense effort to master the manual process. At the end of each exercise is requested visual analysis of the whole process, which takes place by means of a test, in the 1st exercise, and posters and/or videos, in the 2nd and 3rd remaining exercises. Once finished, are exposed and commented, by all.

VIRTUAL REALITY AND VIRTUAL ENVIRONMENTS

VR is a 3-D artificial environment that allows the users to live artificial phenomenon with the intensity once thought to be unique of real life. What makes it possible is the feeling of being indeed somewhere interacting with the objects presented, intuitively and in real time.

Virtual Reality (VR) is distinguished from other systems using Virtual Environments (VEs) and is characterized, according to the Triangle of RV proposed by Burdea and Coiffet (2003), by enhancing the interaction, immersion and imagination, resulting in different levels of presence. The interaction corresponds to the degree of response of the virtual world and all it contains, in real time to user actions and can display realistic or unrealistic behavior. Immersion has to do with the real world isolation level offered by the system and can be more or less immersive systems. Imagination is a variable that depends exclusively on the participant and his willingness to be "deceived". These factors, along with the degree of intrusion and discomfort caused by the devices (e.g., nausea, eyestrain, proficiency with navigation techniques) will result in a variable degree of presence, which aims to be high. The presence can be defined as a convincing sense of presence, in fact, in the virtual world, indicating loss of consciousness that the body remains physically in the real world. When compared with other systems using EVs, the VR systems allow the evaluation of more advanced aspects of interaction with the world, as behaviours or emotions with good ecological validity (e.g., Rebelo, Duarte, Noriega, & Soares, 2011). To assess perceptions such as space, shape, size, and other, EVs may be sufficient, being the example, environment or objects created 3D modeling software (e.g., 3D Studio Max; Sketchup Pro).

VR technology is currently used in a broad range of applications, such as games, movies, simulations, and a few main focus are training, education, collaborative work, therapy and learning (Lanyi, 2012). The technology allow the generation of phenomena, alternative experiences to reality, enabling some of today's most innovative pedagogical approaches (Schank, 2011), however, much of its potential is yet to unveil (Jones, 2013).

VR in the educational setting

It is presently reinforced the growing importance of VR in the learning context, where it facilitates learning abstract concepts, observation of phenomena at different scales, participation in events so far impossible to witness either for reasons of safety, costs, or distance (Abdelaziz, Riad, & Senousy, 2014). Other recent study outlined the effectiveness of virtual reality technology-based instruction (i.e. games, simulation, virtual worlds) in improving learning outcome gains (Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014), reinforcing the already known positive affect of VR-based learning environments on the cognitive and affective domains of learners (Lee, 2011).

Games and Gamification are emergent technologies largely impacting world education, allowing strategies that stimulate collaborative work, creativity and motivation in students and teachers (Monteiro & Barbosa, 2014). As highlighted in the NMC Horizon Report: 2014 Higher Education Edition (Johnson, Adams Becker, Estrada, & Freeman, 2014), in two to three years, those technologies are to be adopted in the high educational context, for educational gameplay has proven to foster engagement in critical thinking, creative problem-solving, and teamwork, skills that lead to solutions for complex social and environmental dilemmas (Johnson et

al., 2014, p. 42). According to a recent study in Portugal, students from all cycles of education levels are players, from which, 94.7% male and 77.4% female students are from the secondary level (Carvalho et al., 2014). Most of these game player students are now, or are going to be, entering the tertiary education.

Using 3D Virtual Environments for learning enable tasks that lead to improvement of spatial representation; more opportunities to learn from experience; increase motivation / interplay; enhance the context of learning; and enrich collaborative learning compared to 2D alternatives (Dalgarno & Lee, 2010). In the educational setting, VR allows observation from multiple perspectives, which encourages diverse ways of thinking, (Lee, 2011, p. 2) and it can be used to promote the transfer of learning (Bossard, Kermarrec, Buche, & Tisseau, 2008).

An exploratory study within the Virtual Reality for Kids interested in Design Studies (VR-KIDS) evaluated design skills of children between the ages of 11 and 16 before and after an activity using Virtual Reality (Souza, Yoon, & Islam, 2011). It showed that VR interface considerably increased logical, kinesthetic and naturalist skills, negatively affected verbal and intrapersonal skills and had no effect on spatial and interpersonal skills. Also VR interface was useful for less skilful students (Souza et al., 2011).

ANTICIPATING AN ALLIANCE BETWEEN VR AND BASIC DESIGN

Our pedagogical approach at 3D Design Lab, although supported by the traditional Basic Design education, is faced with the announced inevitability of VR presence in the future of design education (Colucci, 2011) and its positive impact in the educational context. However, much work has to be done in order to evidence the qualities of the partnership between VR and Basic Design and consequently, research is mandatory. VR technology can reveal to us not only a new means of expression in basic design (innovation in terms of content), but also, effective procedures for human development (innovation in pedagogic level). Some possible contributions of VR for 3D Design Lab can now be deducted and conceptually formulated.

A profound investigation concluded that remains essential for design students to develop perceptual motor skills such as manual modelling and manipulation of materials, despite the advance and common application of computer based design tools (Boucharenc, 2006, p. 18). Sorby (1999) highlights, in this respect, the benefit of the manual-visual articulation for the spatial visualization, an essential competence for designers, that VR systems can amplify (Sik-Lányi, Lányi, & Tilinger, 2003, p. 293). Though advocated the use of computers to design 2D, Wucius Wong (1995, p. 239) considers that three-dimensional shapes are better understood in real space, *"in which all the dimensions necessary for the understanding of the ideas mass, depth and area of flow, as well as the nature of the various materials is provided"*.

At 3D Design Lab, as already mentioned, the teacher orients the explorations undertaken by each student, observing emotions and actions, prompting immediate feedback, for what explanations and/or citations are used verbally. In between metaphors and analogies, citations are cues that work for unblocking difficulties, triggering actions and possible solutions for the problems faced by the students, leading them in his/her way out. As known, metaphors increase the activity in the design process, advancing new understanding and new actions, according the experience and personality of each student, besides assisting to grasp abstract concepts (Coyne, Snodgrass, & Martin, 1994, 115). We are also familiarized with the effect of analogies on design activity, a cognitive strategy that largely benefit novices, rather than experts and leads to better understand abstract concepts, besides retrieving and implementing previously acquired knowledge (Casakin & Goldschmidt, 1999; Goldschmidt, 2001). Analogies are also recognized for alleviating fixation, a consequence of using physical prototyping (Chandrasekera, 2014), for which the author advances a proposal for using digital modelling using Augmented Reality (2014).

The referred verbal citations link the abstract models to any known real situation: specific objects, forms, functions, daily life scenarios, revealing a powerful instrument for the teaching and learning at 3D Design Lab. Within this context, a common task to all three exercises, in different phases, could benefit from the use of VR. The abstract objects appear themselves to the students, at first, as strange foreign entities with which they are not identified. Gradually, the interest and motivation increases as experiences move on, sometimes set off by verbal suggestions of *"what it could be"*, providing the emotional impulse to act-reflect in a recursive way. The imagination is then released and the search for new and interesting results signals a good learning outcome. However, that kind of approach is not effective for all students, with a few persisting in a disengaged and careless attitude. Also, others declare a personal missing enthusiasm for manual tasks, excusing their low performance. In this situation, setting a new environment, like VR, can be benefic, for what is known, different environments provoke distinct cognitive action types (Gul, 2009, p. 615), reaching out also other learning styles. Perceptive-manipulative experience in a 3D virtual environment like VR could benefit the learning process at 3D Design Lab, as it may trigger emotions and actions in a more effective way for students presenting more difficulties within the traditional process. According to Lee (2011, p. 44), different learning styles not only im-

pact interaction experience (e.g. how easily the user can interact with the system) but also learning experience (e.g. motivation) (Lee, 2011, p. 44).

A protocol analysis experiment conducted with expert designers revealed that in digital design environments perceptual actions seem to be more frequent than in traditional real environments, as the previous condition provide a platform for designers to easily focus on the visual analysis of the design solution, probably due the simple way of control navigation and camera views, as well as the relatively realistic appearance of the design model (Gul, 2009, p. 621). Therefore, we deduce that VR technology could afford the opportunities to engage more students in the perceptual actions, for the lack of the referred cognitive dimension can be negatively affecting motivation, enthusiasm and eventually, performance results.

Being able to foresee multiple different scenarios and/or concrete applications for the abstract objects is essential for developing more complex and interesting forms, as part of Knauer's operative aesthetic methodology (2008, p. viii). Complementing verbal citations with visual-manipulative ones, in real and virtual environments, could set the necessary impulse to act in some more effective ways. Abstract design principles, the main focus of Basic Design education, can be extended to different scenarios and contexts (real or imagined). VEs could amplify the concepts understanding to a bigger audience, especially to those having more difficulties succeeding in performing some of the tasks usually accomplished in the traditional way, besides reinforcing them to all students. Affording a virtual space for manipulation of owns abstract forms in some simple aspects could be beneficial for effective learning, engagement and learning experiences.

The designer as provocative of emotions and actions (Bonsiepe, 2011, p. 53) can benefit from VR, through experiences applying the perception of their own emotions and those of others, at different levels of immersion and different situations/scenarios. Providing multiple and varied experiences by allowing easy manipulation, in terms of core operations, i.e., symmetry operations, can foster a higher engagement and better learning.

Adopting ergonomic terminology in product design, a scenario incorporates a context of use of a product (e.g., school, hospital, transport, industrial, agricultural) and a set of tasks that one or more users perform or intend to carry (Fulton Suri & Marsh, 2000; Nardi, 1992). Thus, exposure to different scenarios will allow potential users present their ideas and / or questions about your interaction with the concepts of a product, in existing or future contexts. These scenarios can be used in various stages of development of a product and can serve to understand their features, develop attributes of a product or assess user behavior in critical situations interaction with a product or system. We can use different media to implement these scenarios; e.g., narratives written with or without illustrations; video narratives; drama with real characters or interactive virtual environments.

Quasi-experiments are frequently adopted in educational setting, with no random selection of participants (Creswell 2013), as conducted in the LiFE 1 project. Quasi-experimental methodology was used to determine the most effective type of 3D experiences on pupil learning and achievement and measured the value and impact of these experiences. Students were tested and measured before and after the lessons, with a "control" group learning in 2D only, and the other group receiving the same instruction plus 3D (Bamford, 2011). Also Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis (2014) performed experimental or quasi-experimental research designs to evaluate the effects of the virtual reality-based instruction on K-12 and higher education settings, and used a learning outcome measure. Accordingly, this methodology could be helpful to determine the impact of integrating VR technology in Basic Design education. This quantitative methodology requires a pre-post design for cognitive and performance evaluation, for which the dependent variables can be: conception time; complexity (number of parts of the elements and motifs); quality of the proposal. Also important are the variables related with the quality of the experience and the engagement in the learning experience, related with the sense of presence of the student in the experience, such as: interaction; immersion of the system; and imagination.

CONCLUSION

Despite the permanently reaffirmed relevance and timelessness of the pedagogical model initially called Vorkus, Basic Design seems to resist the advances of digital technologies, namely, Virtual Reality. For Findeli (1990, p. 18), the pedagogic approach stated a hundred years ago, persist on showing it's adequacy in the present century (2001, p. 14). It's pillars being the interactions, and with it, the properties of the systems generated and transformed, in all human areas, the investment should continue to be done in the leading part of those actions: emotions. Those are what determine each of our acts, and therefore, all activities we engage. Supporting 3D Design Lab is Knauer's operative aesthetic, a methodology for conducting a personal language out of an abstract elementary unity form that always asks for citations, connections to the senses and emotions. In order

to keep the pace in the present era, with all the new ways of interacting and learning the new generation is increasingly familiarized with, we should provide them the opportunity to learn the Basics of Design accordingly. It requires, in line with the pedagogy of design, manipulating the invisible interactions in such a way that evokes spontaneity and intuition for them. Those ways are now set out in the virtual space, the new familiar environments from the new era that is showing to be effective for engagement and motivation, and learning, under the right conditions.

The features of the new technologic mediums, namely, VR, offer great opportunities for trying safely and with lesser costs, tasks otherwise impossible in the traditional setting. The models created by hand, in each of the three exercises, once transposed into digital format, e.g., using simple 3D modeling software, can be experienced in an infinite ways, at different scales, benefiting all areas of design, especially interior/environment design. Feeling their own creations as real life objects could work as an upgrade to the traditional verbal "citations" that never seem to result for all. Subsequently, bonds with students own creations could open up a world of possibilities for co-transformation of objects and themselves, and in this sense, the new alliance could contribute to overcome moments of anxiety, easily open the way to self-expression and to a new dimension of emotion discovery. By adding the new medium, new elements could be introduced like colour, texture, light, movement and music, so that more complexity and expressive potential could be added. Also different points of view, distances and scales could benefit perception skills, visualization and imagery imagination, prompting creativity.

Therefore, investing in VEs, and specifically, VR, can turn some light to the problem of introducing the future generations in the creative activity, that is, design. We hope this study had sparked the debate about the craft of new kind of meaningful teaching and learning experiences in Basic Design education.

REFERENCES

- Abdelaziz, M., Riad, A., & Senousy, M. (2014). Challenges and Issues in Building Virtual Reality-Based e-Learning System. *International Journal of e-Education, e-Business, e-Management and e-Learning*, 4(4), 320–328.
- Arnett, J. J. (2004). *Emerging Adulthood: The Winding Road from the Late Teens through the Twenties* (1 edition). New York ; Oxford: Oxford University Press.
- Bamford, A. (2011). *LiFE: Learning in Future Education Evaluation of innovation in learning using emerging technologies* (Project).
- Besgen, A., Kuloglu, N., & Fathalizadehalemdari, S. (2015). Teaching/Learning Strategies Through Art: Art and Basic Design Education. *Procedia - Social and Behavioral Sciences*, 182, 428–432. <http://doi.org/10.1016/j.sbspro.2015.04.813>
- Bonsiepe, G. (1975). *Teoria e prática do design industrial: elementos para um manual crítico* (1992 - 1ª ed portuguesa). Lisboa: Centro Português de Design.
- Bonsiepe, G. (2011). *Design, Cultura e Sociedade*. São Paulo, Brasil: Edgard Blucher.
- Bonsiepe, G. (2012). *Design como Prática de Projeto*. Brasil, S. Paulo: Edgard Blucher.
- Bossard, C., Kermarrec, G., Buche, C., & Tisseau, J. (2008). Transfer of learning in virtual environments: a new challenge? *Virtual Reality*, 12(3), 151–161. <http://doi.org/10.1007/s10055-008-0093-y>
- Boucharenc, C. G. (2006). Research on Basic Design Education: An International Survey. *International Journal of Technology and Design Education*, 16(1), 1–30. <http://doi.org/10.1007/s10798-005-2110-8>
- Burdea, G. C., & Coiffet, P. (2003). *Virtual Reality Technology* (2 edition). Hoboken, NJ: Wiley-IEEE Press.
- Carvalho, A. A., Araújo, I., Zagalo, N., Gomes, T., Barros, C., Moura, A., & Cruz, S. (2014). Os jogos mais jogados pelos alunos do Ensino Básico ao Ensino Superior. Em A. Carvalho, S. Cruz, C. Marques, A. Moura, & I. Santos (Eds.), *Atas do 2º Encontro sobre Jogos e Mobile Learning* (pp. 74–84). Universidade do Minho. Instituto de Educação. Centro de Investigação em Educação (CIEd).
- Casakin, H., & Goldschmidt, G. (1999). Expertise and the use of visual analogy: implications for design education. *Design Studies*, 20(2), 153–175.
- Cetinkaya, C. (2014). Basic Design Education Parameters in Turkey. Em *Humanitas International Journal of Social Sciences* (pp. 31–46). Central and Eastern European Online Library.
- Chandrasekera, T. (2014). Using Augmented Reality Prototypes in Design Education. *Design and Technology Education: An International Journal*, 19(3). Obtido de <https://ojs.lboro.ac.uk/ojs/index.php/DATE/article/view/1971>
- Colucci, K. (2011). What role will technology play in the future of design education. Em *Icograda Design Education Manifesto 2011* (pp. 63–67). Obtido de http://toolkit.icograda.org/database/rte/files/PR_IEN_Manifesto2011_webres.pdf
- Coyne, R., Snodgrass, A., & Martin, D. (1994). Metaphors in the Design Studio. *Journal of Architectural Education* (1984-), 48(2), 113–125. <http://doi.org/10.2307/1425318>
- Creswell, J. W. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition* (4th edition). Thousand Oaks: SAGE Publications, Inc.
- Dalgarno, B., & Lee, M. (2010). What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology*, 41(1), 10–32.
- Droste, M. (1992). *Bauhaus 1919-1933*. Alemanha: Taschen.
- EDLB. (2012). Design for Growth and Prosperity. Obtido 27 de Março de 2014, de <http://www.beda.org/resources/other-publications/design-for-growth-and-prosperity.html>

- Federle, G. (2009). *Basic Design La formazione al design nella Scuola secondaria* [Doutoramento]. Università Ca' Foscari Venezia, Venezia, Italia. Obtido de http://dspace.unive.it/bitstream/handle/10579/1016/Tesi_Federle_2010.pdf?sequence=1
- Fernandes, R. (2011). *Design, Informação e Desenvolvimento: um contributo metodológico para a exploração do «Potencial Informativo do Produto» como fator de percursos de rápida «mudança emergente» orientada para o desenvolvimento*. Universidade Complutense de Madrid, Madrid.
- Fernandes, R. (2013). Programa da UC Design Tridimensional.
- Findeli, A. (1990). Moholy-Nagy's Design Pedagogy in Chicago (1937-46). *Design Issues*, 7(1), 4–19. <http://doi.org/10.2307/1511466>
- Findeli, A. (2001). Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion. *Design Issues*, 17(1), 5–17. <http://doi.org/10.1162/07479360152103796>
- Fulton Suri, J., & Marsh, M. (2000). Scenario building as an ergonomics method in consumer product design. *Applied Ergonomics*, 31(2), 151–157. [http://doi.org/10.1016/S0003-6870\(99\)00035-6](http://doi.org/10.1016/S0003-6870(99)00035-6)
- Goldschmidt, G. (2001). Visual Analogy—a Strategy for Design Reasoning and Learning. Em C. M. Eastman, W. M. McCracken, & W. C. Newstetter (Eds.), *Design Knowing and Learning: Cognition in Design Education* (pp. 199–219). Oxford: Elsevier Science. Obtido de <http://www.sciencedirect.com/science/article/pii/B9780080438689500097>
- Gul, L. F. (2009). Studying the Impact of Immersion on Design Cognition. Em *Computation: The New Realm of Architectural Design: 27th eCAADe Conference Proceedings* (pp. 615–622). Istanbul Technical University, Faculty of Architecture.
- Gu, N., Gul, L. F., & Williams, A. (2010). Methods for evaluating 3D Virtual Worlds in Design Education. Em *International Design Conference - Design 2010* (pp. 1259–1266). Dubrovnik - Croatia.
- Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2014). *MC Horizon Report - 2014 Higher Education Edition*. Austin, Texas. Obtido de <http://www.nmc.org/pdf/2014-nmc-horizon-report-he-EN.pdf>
- Jones, D. (2013). An Alternative (to) Reality. Em M. Childs & A. Peachey (Eds.), *Understanding Learning in Virtual Worlds*. New York: Springer.
- Knauer, R. (2008). *Transformation. Basic Principles and Methodology of Design* (1.ª ed.). Birkhäuser GmbH.
- Kvan, T. (2001). The pedagogy of virtual design studios. *Automation in Construction*, 10(3), 345–353. [http://doi.org/10.1016/S0926-5805\(00\)00051-0](http://doi.org/10.1016/S0926-5805(00)00051-0)
- Lányi, C. (Ed.). (2012). *Applications of Virtual Reality*. InTech.
- Lee, E. A. L. (2011). *An investigation into the effectiveness of virtual reality-based learning* (phd). Murdoch University. Obtido de <http://researchrepository.murdoch.edu.au/4070/>
- Maldonado, T. (1981). *El Diseño Industrial Reconsiderado*. Barcelona: Gustavo Gili.
- Maldonado, T. (2012). O corpo humano e o conhecimento digital. Em *Cultura, Sociedade e Técnica*. Edgard Blucher.
- Marcolli, A. (1971). *Teoria del Campo - corso di educazione alla visione* (1998.ª, 17ª ed. ed.). Milano: Sansoni Editore.
- Marcolli, A. (1978). *Teoria del Campo 2 - corso di metodologia dalla visione* (1991, 3ª ed.). Itália, Firenze: Sansoni Editore.
- Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, 70, 29–40. <http://doi.org/10.1016/j.compedu.2013.07.033>
- Monteiro, R., & Barbosa, H. (2014). Challenges Game: um jogo dinamizador do processo de ensino. Em A. Carvalho, S. Cruz, C. Marques, A. Moura, & I. Santos (Eds.), *Atas do 2º Encontro sobre Jogos e Mobile Learning* (pp. 74–84). Universidade do Minho. Instituto de Educação. Centro de Investigação em Educação (CIEd).
- Munari, B. (1979). *Arista e Designer*. Lisboa: Editorial Presença/Martins Fontes.
- Munari, B. (1995). *Design e Comunicação Visual*. Lisboa: Edições 70.
- Nardi, B. A. (1992). The use of scenarios in design. *SIGCHI Bull.*, 24(3), 13–14.
- Pink, D. H. (2006). *A Whole New Mind: Why Right-Brainers Will Rule the Future*. Penguin.
- Rebelo, F., Duarte, E., Noriega, P., & Soares, M. M. (2011). Virtual Reality in Consumer Product Design: Methods and Applications. Em Waldemar Karwowski, Marcelo M. Soares, & Neville A. Stanton (Eds.), *Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques* (pp. 381–402). CRC Press.
- Schank, R. (2011). *Teaching Minds: How Cognitive Science Can Save Our Schools*. Teachers College Press.
- Sik-Lányi, C., Lányi, Z., & Tilinger, A. (2003). Using Virtual Reality to Improve Space and Depth Perception. *Journal of Information Technology Education*, 2, 291–303.
- Sorby, S. A. (1999). Developing 3-D Spatial Visualization Skills. *Engineering Design Graphics Journal*, 63(2). Obtido de <http://diggingdeeper.pbworks.com/f/Developing+Spatial+Skills.pdf>
- Souza, N. D', Yoon, S.-Y., & Islam, Z. (2011). Understanding design skills of the Generation Y: An exploration through the VR-KiDS project. *Design Studies*, 32(2), 180–209. <http://doi.org/10.1016/j.destud.2010.07.002>
- Steadman, P. (2008). *The Evolution of Designs: Biological Analogy in Architecture and the Applied Arts*. USA and Canada: Routledge.
- Wong, W. (1995). *Fundamentos del diseño* (4ª ed.). Espanha, Barcelona: Gustavo Gili.

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USING VIRTUAL ENVIRONMENTS IN BASIC DESIGN EDUCATION

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ABSTRACT

The aim of this paper is to present a reflection about the potentiality and interest of Virtual Reality (VR) for innovation in the Basic Design education. Basic Design is about affording meaningful learning experiences to the newly arrived design students while introducing the design fundamentals. Without approaching real design problems, but abstract phenomena creation, Basic Design allows unique opportunity for self-expression and discovery. At a present course named 3D Design Lab, different construction principles provide combinatory training for generation and transformation of surfaces/patterns, volumes and spaces, according to the transformative geometry. Abstract forms manually crafted at hand scale foster a methodology for structure complexity while developing an aesthetic-projective attitude. In this context, several challenges faced by the students, such as bonding with the abstract forms; imagining different possible applications for them in the real world; and others, can be overcome within the alliance with VR. This technology is also known for promoting a sense of presence that positively affects the designer in the creative process, improve spatial visualization and, in certain conditions, enhance students learning outcomes. As discussed further, VR might impact positively the teaching and learning experiences at the course, and hence, Basic Design. Consequently, we will present the origins, utility and main theoretical concepts of Basic Design and 3D Design Lab, as well as introduce VR, its main advantages and inconveniences. Finally, possible ways of using VR in Basic Design education are advanced, from a conceptual point of view, hoping to motivate the research community for further study this possibility.

Keywords: Basic Design; 3D Design Lab; Virtual Reality (VR) and Virtual Environments (VEs).

INTRODUCTION

Given the pressing social challenges and the profound changes required in all areas of activity, the designer, creator of interfaces that mediate everyday action, is increasingly requested. Recommendations were made to improve design literacy in Europe¹ providing every citizen with capabilities to transform tangible and/or intangible objects in each sector of life. Design is also known as being part of a set of senses that all individuals need to develop to overcome the conceptual age, along with Story, Symphony, Empathy, Play and Meaning².

Increasingly sooner familiar with the new digital technologies, the XXI century designers print a changing point into current teaching methodologies. The irreversibility and intensification of this phenomenon have driven the practice and evaluation of new learning environments and teaching methods. Also design education faces new challenges and opportunities, delivering new pedagogical approaches³.

Basic Design, however, remains an unexplored field regarding the use and impact of new technologies in the teaching-learning process, specifically, Virtual Reality (VR), setting a venue for research. This exploratory study presents some evidences for eventual advantages and inconveniences of that partnership, while considering the case of a present course, 3D Design Lab. Rooted in Basic Design education, the discipline reaffirms the adequacy of the referred pedagogy in the present and future of design education, where the contribute of VR technology is a possible near scenario. The validation of this statement is the main goal of a research project conducted as part of a doctoral program that will provide possible means for assessing the impact of the VR technology: in overcoming some difficulties expressed by the first year design students under the present conditions; in the performance differentials and/or lead times; in the level of involvement/engagement in the task; and in the overall quality of user experience (UX).

BASIC DESIGN EDUCATION

At university design education programs, Basic Design is still a very important component⁴. It refers to the teaching and learning of design fundamentals, or the Principles of Two-and Three-dimensional Design⁵. Other authors prefer the term Design Patterns, as Bonsiepe⁶, thereby overcoming the lack of consensus on the most widespread expression: Basic Design. We refer to the propedeutic training of projective disciplines, disseminated from the experience of the Bauhaus School (1919-33). Decisive moments in its evolution were also those perpetrated by Moholy-Nagy and Chermayeff, at the New Bauhaus, in Chicago (1937-55), and subsequently, by Max Bill, Otl Aicher and Tomás Maldonado, at Hochschule für Gestaltung, in Ulm (1953-68).

Basic Design, as it is more commonly known, is the pedagogical model invented in Bauhaus to introduce students in the design fundamentals in a rational way whilst linking the related knowledge, attitudes and skills derived from the study of Basic Design to the pedagogy of design practice⁷. The journey develops more an attitude than a profession, built on the dichotomic pedagogical principle "intuition and method" or "subjective experience and objective recognition"⁸. Basic Design education is actually considered the effort of expressing the abilities and power of creativity in aesthetic level and transfer of thinking, emotions, and impressions of a person⁹.

Some characteristic of that initial formative period of the designer are the aesthetic and formal exercises, exploration of color, composition and texture, in order to train the sensitivity for the aesthetical-projectual phenomenon, and where the technical and physical factors of the materials, ergonomics, costs, manufacturing processes and even the function, are not considered¹⁰.

Design competencies are needed in a varied of fields and professions. According to the pedagogy spread by Moholy-Nagy, they should be developed through activities aimed at the ability to express the design elements (line, shape, color, space, movement, texture, volume) in various media, starting with tangible two-dimensional and three-dimensional (pen, pencil, paper, clay, wood); and then, intangible (light, space and sound). These explorations required the same kind of interaction with the world, the same perceptive-retinal-action used in everyday life. Findeli declares Basic Design the best pedagogic tool for developing visual intelligence in the present century. That skill allows the understanding and transformation of the invisible relations between the system's elements, in all its complexity¹¹.

Also Marcolli's pedagogy (1971), based on the perceptive types of E. Bullough, relegates to the current era a proposal for developing the visual perception for project activity in multiple fields of human action, including design. Such development takes place through four successive fields/spaces: geometric-intuitive; gestalt; topological; and phenomenological. They are implemented by the transformational geometry: Euclidean; affine and projective; topological; and set theory. Each field is, in turn, addressed according to its structure; the composition of objects; object-field interaction; and finally, tension and

movement. The scientific literature is silent regarding Marcolli's projectual pedagogy, a fact which may be due either to the unfamiliar language, as the high level of theoretical abstraction¹².

Knauer's recent approach to the principles and methodology of design, called Transformations¹³ is a great opportunity for clarifying the transformational processes constitutive of Basic Design pedagogy. According to the author, practicing the true nature of design, the constant combinatory of elements (bar, surface and body), with the leading of aesthetics through abstract forms and a disinterest for function, may be introducing the individual to a design language. That language is developed by the individual's inner force of exploration and expression while mastering a medium. Deepening and amplifying the experiences from one medium empowers the co-generation of form and designers as integrators, as established in Moholy-Nagy's pedagogy. He envisioned, through the one medium manual-perceptive intensive training and mastery, the capacity to understand/intuit the invisible interactions in every phenomenon of the world¹⁴.

Looking in depth Knauer's "Transformations", basis structures consist of formal processes that the imagination's images can be developed via not-yet-fixed structures that have not yet been to a conclusion, more easily and with fewer limitations, leading to surprising possibilities for design and reformulating¹⁵. Accordingly, basis structure consists of a methodologic binding preparation for the form-object complexes. Relating the abstract forms/basis/signifier (form empty of content) to semiotically finished objects citations/function/signified (form related to content), is the process by which the author refers to "assigning citations to basis". Knauer argues, in this sense, that the space of aesthetic cannot be expanded without fictional, emotional and sensory values, requiring for citations, possibilities for its semantic determination. Consequently, "assigning citations to basis" extends imagination by stimulating and motivating, in an intrinsic way, the search for a vocabulary, a morphological collection.

There is also a different approach to the introductory design course, more commonly used in architectural education, Virtual Design Studios (VDS). It addresses a rubric called problem-based learning — PBL, also found in other disciplines such as medicine, engineering and mathematics, among others, and it is largely focused on the idea of presenting students with a real design problem, for exploring solutions, experimenting failure, success and frustration along the way¹⁶. At 3D Design Lab, as in Basic Design education, there are no real problems to be addressed, but opportunities for incorporating, by doing, the principles that underlie the creative process embedded in the prospective act, that is, project.

EXTENDING BASIC DESIGN TRADITION AT 3D DESIGN LAB

Implemented internationally, Basic Design pedagogy has been adapted to the present times¹⁷. Grounded on the Basic Design pedagogy, the methodology currently adopted in Laboratório de Design 3D (3D Design Lab), was revised and updated by Fernandes¹⁸. With a broad frame of reference, 3D

Design Lab stresses the Italian influence of Bruno Munari¹⁹, Attilio Marcolli²⁰ and Tomas Maldonado²¹, since the foundation of Instituto de Artes Visuais, Design e Marketing – IADE, at 1969, pioneering design teaching in Portugal. Recent school options for the discipline align with the theory-methodology of Gui Bonsiepe²² and the proposals of Roland Knauer's transformations²³, in convergence with Steadman's²⁴ latest compositional techniques, closely relating the nature and human action²⁵.

The course is taught at Instituto de Arte, Design e Empresa – Universitário – IADE-U, to the first year design students, also known as emergent adults, individuals between the ages of 18 and 24 that are living ages of: identity explorations; instability; self-focused; feeling in-between, in transition, neither adolescent nor adult; and an unparalleled opportunity to transform their lives²⁶.

The structure of the course

3D Design Lab corresponds to a cross propedeutic training to the three main project areas: visual; industrial; and environments. It aims the incorporation of an investigation method for generating complex systems in parts-totalities-parts, by recursively applying trial and error while provide student engagement in creation / construction of three-dimensional, hand scale, abstract forms, mainly using the hands. The perceptive-retinal-manipulative acts aim the dynamic and transformative nature of space-3D shapes, encourages the release of the mind of pre-established phenomena, and the discovery and reinvention of reality and the individual. Functional aspects of the objects are not taken in consideration, as well as most components of a design project. Are also excluded some of the elements of design usually considered in a Basic Design course, like color and texture. The course focus on developing a sensitivity to the technological and aesthetic phenomena and projetual ability²⁷ over the incorporation of design patterns: field structure; reference mark; elementary part; elementary motif; combinatory; modularity; patterning; symmetry / asymmetry; formal coherence; structural consistency; systemic; complexity; simplicity; maximum diversity with the minimum repertoire; among others. These concepts are repeated throughout the three exercises, moments that reveal the influence of the four perceptive fields defined at Marcolli's projetual pedagogy²⁸.

The exercises at 3D Design Lab consist of activities triggered by minimum action programs, of departure²⁹. Each sequence of actions will conform the object in which it is clear, in a "before and after", the emerged impasses during the process, and the overcoming those difficulties. The regular comments and criticisms to the students work are decisive for the adequate change, and therefore, an essential dialogue for learning and development. In a close orientation with each student, the teacher uses whatever examples and explanations he/she considers adequate for the overcoming the impasses. This unblocking can be considered an important pedagogic instrument, making use of verbally transmitted

cues, resembling Knauer's "citations"³⁰. The principles and concepts are also introduced in the dialogue with students about what is being done rather than being previously exposed. Also, no visual examples are provided, avoiding the natural tendency of novices to rush to obvious results, frequently objects semiotically recognized from the daily life, a fact also reported by Munari³¹. Breaking that attitude with abstract examples is also a common strategy for developing a proper understanding of the creation and transformation process, traditionally used at Basic Design education. According Fernandes methodology, no specific competence is required for the exercises, allowing any supposed unprepared student to overcome difficulties, as they arrive, closely supported by the teacher's feedback. Incorporating the configuration process starts with an operative knowledge and directs itself, through an aesthetic feeling, to a reflective knowledge materialized in a totality/configuration/object.

The traditional learning by doing process is perfectly aligned to Knauer's operative aesthetic³² where the search of the form is leaded, not by the function of any semiotically finished object, but by a constantly increasing of aesthetics, on an abstract form empty of content. In that sense, an increasing growth of complexity within the 3 moments/exercises is provided by: the application of successive levels of perception of space suggested by Marcolli³³; the approaching of 2D before 3D³⁴; and the creation from parts to totalities, in the first and second exercises, to the last one, where the totality of the form is first explored and then, the methodological process determines its constitutive elements. The evaluation of the exercises reflects this increasing of complexity, each one assessed in three categories of competences, with precedency: technique, analytic and aesthetic.

An engaging component is the reaching of the quality in the visual effects, when recognized by the student's themselves and their peers, referring them as interesting, beautiful, and so on. The judgment and criticism of own work and the others is rooted on technical quality and brought by an intense effort to master the manual process. At the end of each exercise is requested visual analysis of the whole process, which takes place by means of a test, in the 1st exercise, and posters and/or videos, in the 2nd and 3rd remaining exercises. Once finished, are exposed and commented, by all.

VIRTUAL REALITY AND VIRTUAL ENVIRONMENTS

VR is a 3-D artificial environment that allows the users to live artificial phenomenon with the intensity once thought to be unique of real life. What makes it possible is the feeling of being indeed somewhere interacting with the objects presented, intuitively and in real time.

Virtual Reality (VR) is distinguished from other systems using Virtual Environments (VEs) and is characterized, according to the Triangle of RV proposed by Burdea and Coiffet³⁵ by enhancing the

interaction, immersion and imagination, resulting in different levels of presence. The interaction corresponds to the degree of response of the virtual world and all it contains, in real time to user actions and can display realistic or unrealistic behavior. Immersion has to do with the real world isolation level offered by the system and can be more or less immersive systems. Imagination is a variable that depends exclusively on the participant and his willingness to be “deceived”. These factors, along with the degree of intrusion and discomfort caused by the devices (e.g., nausea, eyestrain, proficiency with navigation techniques) will result in a variable degree of presence, which aims to be high. The presence can be defined as a convincing sense of presence, in fact, in the virtual world, indicating loss of consciousness that the body remains physically in the real world. When compared with other systems using EVs, the VR systems allow the evaluation of more advanced aspects of interaction with the world, as behaviours or emotions with good ecological validity³⁶. To assess perceptions such as space, shape, size, and other, EVs may be sufficient, being the example, environment or objects created 3D modeling software (e.g., 3D Studio Max; SketchUp Pro).

VR technology is currently used in a broad range of applications, such as games, movies, simulations, and a few main focus are training, education, collaborative work, therapy and learning (Lanyi 2012). The technology allow the generation of phenomena, alternative experiences to reality, enabling some of today’s most innovative pedagogical approaches³⁷, however, much of its potential is yet to unveil³⁸.

VR in the educational setting

It is presently reinforced the growing importance of VR in the learning context, where it facilitates learning abstract concepts, observation of phenomena at different scales, participation in events so far impossible to witness either for reasons of safety, costs, or distance³⁹. Other recent study outlined the effectiveness of virtual reality technology-based instruction (i.e. games, simulation, virtual worlds) in improving learning outcome gains⁴⁰, reinforcing the already known positive affect of VR-based learning environments on the cognitive and affective domains of learners⁴¹.

Games and Gamification are emergent technologies largely impacting world education, allowing strategies that stimulate collaborative work, creativity and motivation in students and teachers⁴². As highlighted in the NMC Horizon Report: 2014 Higher Education Edition⁴³, in two to three years, those technologies are to be adopted in the high educational context, for educational gameplay has proven to foster engagement in critical thinking, creative problem-solving, and teamwork, skills that lead to solutions for complex social and environmental dilemmas⁴⁴. According to a recent study in Portugal, students from all cycles of education levels are players, from which, 94.7% male and 77.4% female students are from the secondary level⁴⁵. Most of these game player students are now, or are going to be, entering the tertiary education.

Using 3D Virtual Environments for learning enable tasks that lead to improvement of spatial representation; more opportunities to learn from experience; increase motivation / interplay; enhance the context of learning; and enrich collaborative learning compared to 2D alternatives⁴⁶. In the educational setting, VR allows observation from multiple perspectives, which encourages diverse ways of thinking⁴⁷ and it can be used to promote the transfer of learning⁴⁸.

An exploratory study within the Virtual Reality for Kids interested in Design Studies (VR-KIDS) evaluated design skills of children between the ages of 11 and 16 before and after an activity using Virtual Reality⁴⁹. It showed that VR interface considerably increased logical, kinesthetic and naturalist skills, negatively affected verbal and intrapersonal skills and had no effect on spatial and interpersonal skills. Also VR interface was useful for less skilful students⁵⁰.

ANTEICIPATING AN ALLIANCE BETWEEN VR AND BASIC DESIGN

Our pedagogical approach at 3D Design Lab, although supported by the traditional Basic Design education, is faced with the announced inevitability of VR presence in the future of design education⁵¹ and its positive impact in the educational context. However, much work has to be done in order to evidence the qualities of the partnership between VR and Basic Design and consequently, research is mandatory. VR technology can reveal to us not only a new means of expression in basic design (innovation in terms of content), but also, effective procedures for human development (innovation in pedagogic level). Some possible contributions of VR for 3D Design Lab can now be deduced and conceptually formulated.

A profound investigation concluded that remains essential for design students to develop perceptual motor skills such as manual modelling and manipulation of materials, despite the advance and common application of computer based design tools⁵². Sorby⁵³ highlights, in this respect, the benefit of the manual-visual articulation for the spatial visualization, an essential competence for designers that VR systems can amplify⁵⁴. Though advocated the use of computers to design 2D, Wucius Wong⁵⁵ considers that three-dimensional shapes are better understood in real space, *"in which all the dimensions necessary for the understanding of the ideas mass, depth and area of flow, as well as the nature of the various materials is provided"*.

At 3D Design Lab, as already mentioned, the teacher orients the explorations undertaken by each student, observing emotions and actions, prompting immediate feedback, for what explanations and/or citations are used verbally. In between metaphors and analogies, citations are cues that work for unblocking difficulties, triggering actions and possible solutions for the problems faced by the students,

leading them in his/her way out. As known, metaphors increase the activity in the design process, advancing new understanding and new actions, according to the experience and personality of each student, besides assisting to grasp abstract concepts⁵⁶. We are also familiarized with the effect of analogies on design activity, a cognitive strategy that largely benefit novices, rather than experts and leads to better understand abstract concepts, besides retrieving and implementing previously acquired knowledge⁵⁷. Analogies are also recognized for alleviating fixation, a consequence of using physical prototyping⁵⁸ for which the author advances a proposal for using digital modelling using Augmented Reality⁵⁹.

The referred verbal citations link the abstract models to any known real situation: specific objects, forms, functions, daily life scenarios, revealing a powerful instrument for the teaching and learning at 3D Design Lab. Within this context, a common task to all three exercises, in different phases, could benefit from the use of VR. The abstract objects appear themselves to the students, at first, as strange foreign entities with which they are not identified. Gradually, the interest and motivation increases as experiences move on, sometimes set off by verbal suggestions of "what it could be", providing the emotional impulse to act-reflect in a recursive way. The imagination is then released and the search for new and interesting results signals a good learning outcome. However, that kind of approach is not effective for all students, with a few persisting in a disengaged and careless attitude. Also, others declare a personal missing enthusiasm for manual tasks, excusing their low performance. In this situation, setting a new environment, like VR, can be benefic, for what is known, different environments provoke distinct cognitive action types⁶⁰ reaching out also other learning styles. Perceptive-manipulative experience in a 3D virtual environment like VR could benefit the learning process at 3D Design Lab, as it may trigger emotions and actions in a more effective way for students presenting more difficulties within the traditional process. According to Lee⁶¹ different learning styles not only impact interaction experience (e.g. how easily the user can interact with the system) but also learning experience (e.g. motivation)⁶².

A protocol analysis experiment conducted with expert designers revealed that in digital design environments perceptual actions seem to be more frequent than in traditional real environments, as the previous condition provide a platform for designers to easily focus on the visual analysis of the design solution, probably due the simple way of control navigation and camera views, as well as the relatively realistic appearance of the design model⁶³. Therefore, we deduce that VR technology could afford the opportunities to engage more students in the perceptual actions, for the lack of the referred cognitive dimension can be negatively affecting motivation, enthusiasm and eventually, performance results.

Being able to foresee multiple different scenarios and/or concrete applications for the abstract objects is essential for developing more complex and interesting forms, as part of Knauer's operative aesthetic methodology⁶⁴. Complementing verbal citations with visual-manipulative ones, in real and virtual environments, could set the necessary impulse to act in some more effective ways. Abstract design principles, the main focus of Basic Design education, can be extended to different scenarios and contexts

(real or imagined). VEs could amplify the concepts understanding to a bigger audience, especially to those having more difficulties succeeding in performing some of the tasks usually accomplished in the traditional way, besides reinforcing them to all students. Affording a virtual space for manipulation of owns abstract forms in some simple aspects could be beneficial for effective learning, engagement and learning experiences.

The designer as provocative of emotions and actions⁶⁵ can benefit from VR, through experiences applying the perception of their own emotions and those of others, at different levels of immersion and different situations/scenarios. Providing multiple and varied experiences by allowing easy manipulation, in terms of core operations, i.e., symmetry operations, can foster a higher engagement and better learning.

Adopting ergonomic terminology in product design, a scenario incorporates a context of use of a product (e.g., school, hospital, transport, industrial, agricultural) and a set of tasks that one or more users perform or intend to carry⁶⁶. Thus, exposure to different scenarios will allow potential users present their ideas and/or questions about your interaction with the concepts of a product, in existing or future contexts. These scenarios can be used in various stages of development of a product and can serve to understand their features, develop attributes of a product or assess user behavior in critical situations interaction with a product or system. We can use different media to implement these scenarios; e.g., narratives written with or without illustrations; video narratives; drama with real characters or interactive virtual environments.

Quasi-experiments are frequently adopted in educational setting, with no random selection of participants⁶⁷, as conducted in the LiFE 1 project. Quasi-experimental methodology was used to determine the most effective type of 3D experiences on pupil learning and achievement and measured the value and impact of these experiences. Students were tested and measured before and after the lessons, with a "control" group learning in 2D only, and the other group receiving the same instruction plus 3D⁶⁸. Also Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis⁶⁹ performed experimental or quasi-experimental research designs to evaluate the effects of the virtual reality-based instruction on K-12 and higher education settings, and used a learning outcome measure. Accordingly, this methodology could be helpful to determine the impact of integrating VR technology in Basic Design education. This quantitative methodology requires a pre-post design for cognitive and performance evaluation, for which the dependent variables can be: conception time; complexity (number of parts of the elements and motifs); quality of the proposal. Also important are the variables related with the quality of the experience and the engagement in the learning experience, related with the sense of presence of the student in the experience, such as: interaction; immersion of the system; and imagination.

CONCLUSION

Despite the permanently reaffirmed relevance and timelessness of the pedagogical model initially called *Vorkurs*, Basic Design seems to resist the advances of digital technologies, namely, Virtual Reality. For Findeli⁷⁰, the pedagogic approach stated a hundred years ago, persists on showing its adequacy in the present century⁷¹. Its pillars being the interactions, and with it, the properties of the systems generated and transformed, in all human areas, the investment should continue to be done in the leading part of those actions: emotions. Those are what determine each of our acts, and therefore, all activities we engage. Supporting 3D Design Lab is Knauer's operative aesthetic, a methodology for conducting a personal language out of an abstract elementary unity form that always asks for citations, connections to the senses and emotions. In order to keep the pace in the present era, with all the new ways of interacting and learning the new generation is increasingly familiarized with, we should provide them the opportunity to learn the Basics of Design accordingly. It requires, in line with the pedagogy of design, manipulating the invisible interactions in such a way that evokes spontaneity and intuition for them. Those ways are now set out in the virtual space, the new familiar environments from the new era that is showing to be effective for engagement and motivation, and learning, under the right conditions.

The features of the new technologic mediums, namely, VR, offer great opportunities for trying safely and with lesser costs, tasks otherwise impossible in the traditional setting. The models created by hand, in each of the three exercises, once transposed into digital format, e.g., using simple 3D modeling software, can be experienced in an infinite ways, at different scales, benefiting all areas of design, especially interior/environment design. Feeling their own creations as real life objects could work as an upgrade to the traditional verbal "citations" that never seem to result for all. Subsequently, bonds with students own creations could open up a world of possibilities for co-transformation of objects and themselves, and in this sense, the new alliance could contribute to overcome moments of anxiety, easily open the way to self-expression and to a new dimension of emotion discovery. By adding the new medium, new elements could be introduced like colour, texture, light, movement and music, so that more complexity and expressive potential could be added. Also different points of view, distances and scales could benefit perception skills, visualization and imagery imagination, prompting creativity.

Therefore, investing in VEs, and specifically, VR, can turn some light to the problem of introducing the future generations in the creative activity, that is, design. We hope this study had sparked the debate about the craft of new kind of meaningful teaching and learning experiences in Basic Design education.

Notes:

¹
EDLB, Design for Growth and Prosperity, 2012.

²
PINK, Daniel. H. *A Whole New Mind: Why Right-Brainers Will Rule the Future*, 2006.

³
GU, Ning, GUL, Leman F., WILLIAMS, Anthony, «Methods for evaluating 3D Virtual Worlds in Design Education», 2010, pp. 1259 - 66.

⁴
BOUCHARENC, Christian, «Research on Basic Design Education: An International Survey», 2006, p. 18.

⁵
Idem, p. 1.

⁶
BONSIEPE, Gui, «The Uneasy Relationship between Design and Design Research», 2007, p. 34.

⁷
op. cit. BOUCHARENC.

⁸
DROSTE, Magdalena, *Bauhaus*, 1992.

⁹
BESGEN, Asu, KULOGLU, Nilgun and FATHALIZADEHALEMDARI, Sara, «Teaching/Learning Strategies Through Art: Art and Basic Design Education», 2015, pp. 428 - 32.

¹⁰
op. cit., BONSIEPE, 2012, p. 74.

¹¹
FINDELI, Alain, «Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion», 2001, p. 14.

¹²
FEDERLE, Giovanni, «Basic Design La formazione al design nella Scuola Secondaria», 2009, p. 22.

¹³
KNAUER, Roland, *Transformation. Basic Principles and Methodology of Design*, 2008.

¹⁴
op. cit. FINDELI, 1990, pp. 4 - 19.

¹⁵
op. cit. KNAUER, p. vi.

¹⁶
KVAN, Thomas, «The pedagogy of virtual design studios», 2001, pp. 345 - 53.

¹⁷
CETINKAYA, Cigdem, «Basic Design Education Parameters in Turkey», 2014, pp. 31 - 46.

¹⁸
FERNANDES, Rosa, «Design, Informação e Desenvolvimento: um contributo metodológico para a exploração do "Potencial Informativo do Produto" como fator de percursos de rápida "mudança emergente" orientada para o desenvolvimento», 2011.

¹⁹
MUNARI, Bruno, *Arista e Designer*, 1979.

²⁰
MARCOLLI, Attilio, *Teoria del Campo*, 1998; 1991.

²¹
MALDONADO, Tomás, «O corpo humano e o conhecimento digital», 2012, pp. 119-150; 1981.

²²
op. cit. BONSIEPE, 2012; 1992; 1999.

²³
op. cit. KNAUER.

²⁴
STEADMAN, Philip, *The Evolution of Designs: Biological Analogy in Architecture and the Applied Arts*, 2008.

²⁵
op. cit., FERNANDES, 2013.

²⁶
ARNETT, Jeffrey Jensen, *Emerging Adulthood: The Winding Road from the Late Teens through the Twenties*, 2004, p. 8.

²⁷
op. cit. BONSIEPE, 2012, p. 77.

²⁸
op. cit. MARCOLLI, 1998; 1991.

²⁹
op. cit. FERNANDES, 2011.

³⁰
op. cit. KNAUER.

³¹
op. cit. MUNARI, 1995.

³²
op. cit. KNAUER, p. vi.

³³
op. cit. MARCOLLI, 1971.

³⁴
op. cit. BONSIEPE, 1992; WONG, Wucius, 1995.

³⁵
BURDEA, Grigore C., COIFFET, Philippe, *Virtual Reality Technology*, 2003.

- 36
REBELO, Francisco, et al., «Virtual Reality in Consumer Product Design: Methods and Applications», 2011, pp. 381 - 402.
- 37
SCHANK, Roger, *Teaching Minds: How Cognitive Science Can Save Our Schools*, 2011.
- 38
JONES, Derek, «An Alternative (to) Reality» 2013, pp. 1 - 20.
- 39
ABDELAZIZ, Marwa, RIAD, Alaa and SENOUSY, M. Badr, «Challenges and Issues in Building Virtual Reality-Based e-Learning System», 2014, pp. 320 - 28.
- 40
MERCHANT, Zahira, et al., «Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis», 2014, pp. 29 - 40.
- 41
LEE, Elinda Ai Lim, *An Investigation into the Effectiveness of Virtual Reality-Based Learning*, 2011.
- 42
MONTEIRO, Ricardo, BARBOSA, Helena, «Challenges Game: um jogo dinamizador do processo de ensino», 2014, pp. 74 - 84.
- 43
JOHNSON, L. et al., *MC Horizon Report — 2014 Higher Education Edition*, 2014.
- 44
Idem, p. 42
- 45
CARVALHO, Ana Amélia, et al., «Os jogos mais jogados pelos alunos do Ensino Básico ao Ensino Superior», 2014, pp. 74-84.
- 46
DALGARNO, Barney and LEE, Mark, «What are the learning affordances of 3-D virtual environments?», 2010, pp. 10 - 32.
- 47
op. cit. LEE, 2011, p. 2.
- 48
BOSSARD, Cyril, et al., «Transfer of Learning in Virtual Environments: A New Challenge?», 2008, pp. 151 - 61.
- 49
D'SOUZA, Newton, YOON, So-Yeon and ISLAM, Zahidul, «Understanding design skills of the Generation Y: An exploration through the VR-KIDS project», 2011, pp. 180-209.
- 50
Idem
- 51
COLUCCI, Katia, «What role will technology play in the future of design education», 2011, pp. 63 – 67.
- 52
op. cit. BOUCHARENC, p. 18.
- 53
SORBY, Sheryl A., «Developing 3-D Spatial Visualization Skills», 1999, pp. 21-33.
- 54
SIK LÁNYI, Cecília, et al., «Using Virtual Reality to Improve Space and Depth Perception», 2003, p. 293.
- 55
op. cit. WONG, p. 239.
- 56
COYNE, Richard, et al., «Metaphors in the Design Studio», 1994, pp. 113 - 25.
- 57
CASAKIN, Herman, GOLDSCHMIDT, Gabriela, «Expertise and the use of visual analogy: implications for design education», 1999, pp. 153 - 75.
- 58
CHANDRASEKERA, Tilanka, «Using Augmented Reality Prototypes in Design Education», 2014, 33 - 42.
- 59
Idem.
- 60
GUL, Leman F., «Studying the Impact of Immersion on Design Cognition», 2009, p. 615.
- 61
op. cit. LEE, p. 44.
- 62
Idem.
- 63
op. cit. GUL, p. 621.
- 64
op. cit. KNAUER, p. viii.
- 65
op. cit. BONSIÉPE, 2011, p. 53.
- 66
FULTON SURI, Jane and MARSH, Matthew, «Scenario building as an ergonomics method in consumer product design», 2000, pp. 151 - 57; NARDI, Bonnie A., «The use of scenarios in design», pp. 13 - 14, 1992.
- 67
CRESWELL, John, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 2013.
- 68
BAMFORD, Anne, «LiFE: Learning in Future Education Evaluation of innovation in learning using emerging technologies», 2011.
- 69
MERCHANT, Zahira, et al., «Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis», 2014, pp. 29 - 40.

REFERENCES

ABDELAZIZ, Marwa, RIAD, Alaa and SENOUSY, M. Badr. (2014). «Challenges and Issues in Building Virtual Reality-Based e-Learning System». *International Journal of e-Education, e-Business, e-Management and e-Learning* 4 (4): 320–28.

ARNETT, Jeffrey Jensen. (2004). *Emerging Adulthood: The Winding Road from the Late Teens through the Twenties*. 1 edition. New York; Oxford: Oxford University Press.

BAMFORD, Anne. (2011). «LIFE: Learning in Future Education Evaluation of innovation in learning using emerging technologies». Project.

BESGEN, Asu, KULOGLU, Nilgun and FATHALIZADEHALEMDARI, Sara. (2015). «Teaching/ Learning Strategies Through Art: Art and Basic Design Education». *Procedia - Social and Behavioral Sciences*, 4th WORLD CONFERENCE on EDUCATIONAL TECHNOLOGY RESEARCHES (WCETR-2014), 182 (Maio): 428–32. doi:10.1016/j.sbspro.2015.04.813.

BONSIEPE, Gui. (1975). *Teoria e prática do design industrial: elementos para um manual crítico*. 1992 - 1ª ed portuguesa. Lisboa: Centro Português de Design.

_____. (1999). *Del Objeto a la Interfase*. Buenos Aires, Argentina: Ediciones Infinito.

_____. (2007). The Uneasy Relationship between Design and Design Research. In *Design Research Now: Essays and Selected Papers*, ed: Ralf Michel, 25–39. Germany: Birkhäuser Architecture.

_____. (2011). *Design, Cultura e Sociedade*. São Paulo, Brasil: Edgard Blucher.

_____. (2012). *Design como Prática de Projeto*. Brasil, S. Paulo: Edgard Blucher.

BOSSARD, Cyril, et al. (2008). «Transfer of Learning in Virtual Environments: A New Challenge?». *Virtual Reality* 12 (3): 151–61. doi:10.1007/s10055-008-0093-y.

BOUCHARENC, Christian. (2006). «Research on Basic Design Education: An International Survey». *International Journal of Technology and Design Education* 16 (1): 1–30. doi:10.1007/s10798-005-2110-8.

BURDEA, Grigore C. and COIFFET, Philippe. (2003). *Virtual Reality Technology*. 2 edition. Hoboken, N.J.: Wiley-IEEE Press.

CARVALHO, Ana Amélia, et al. (2014). «Os jogos mais jogados pelos alunos do Ensino Básico ao Ensino Superior». Em *Atas do 2º Encontro sobre Jogos e Mobile Learning*, editado por A. Carvalho, S. Cruz, C. Marques, A. Moura, e I. Santos, 74–84. Universidade do Minho. Instituto de Educação. Centro de Investigação em Educação (CIEd).

CASAKIN, Hernan and GOLDSCHMIDT, Gabriela. (1999). «Expertise and the use of visual analogy: implications for

design education». *Design Studies* 20 (2): 153–75.

CETINKAYA, Cigdem. (2014). «Basic Design Education Parameters in Turkey». Em *Humanitas International Journal of Social Sciences*, 31–46. Central and Eastern European Online Library.

CHANDRASEKERA, Tilanka. (2014). «Using Augmented Reality Prototypes in Design Education». *Design and Technology Education: An International Journal* 19 (3): 33–42. <https://ojs.lboro.ac.uk/ojs/index.php/DATE/article/view/1971>.

COLUCCI, Katia. (2011). «What role will technology play in the future of design education?». Em *Incograda Design Education Manifesto 2011*, 63–67. http://toolkit.icograda.org/database/rte/files/PR_IEN_Manifesto2011_webres.pdf.

COYNE, Richard, SNODGRASS, Adrian and MARTIN, David. (1994). «Metaphors in the Design Studio». *Journal of Architectural Education (1984-)* 48 (2): 113–25. doi:10.2307/1425318.

CRESWELL, John W. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 4th edition. Thousand Oaks: SAGE Publications, Inc.

DALGARNO, Barney and LEE, Mark. (2010). «What are the learning affordances of 3-D virtual environments?». *British Journal of Educational Technology* 41 (1): 10–32.

DROSTE, Magdalena. (1992). *Bauhaus 1919-1933*. Alemanha: Taschen.

D'SOUZA, Newton, YOON, So-Yeon and ISLAM, Zahidul. (2011). «Understanding design skills of the Generation Y: An exploration through the VR-KIDS project». *Design Studies* 32 (2): 180–209. doi:10.1016/j.destud.2010.07.002.

EDLB. (2012). «Design for Growth and Prosperity». <http://www.beda.org/resources/other-publications/design-for-growth-and-prosperity.html>.

FEDERLE, Giovanni. (2009). «Basic Design La formazione al design nella Scuola secondaria». PhD, Venezia, Italia: Università Ca' Foscari Venezia. http://dspace.unive.it/bitstream/handle/10579/1016/Tesi_Federle_2010.pdf?sequence=1.

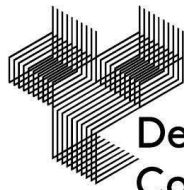
FERNANDES, Rosa. (2013). «Programa da UC Design Tridimensional».

_____. (2011). «Design, Informação e Desenvolvimento: um contributo metodológico para a exploração do "Potencial Informativo do Produto" como fator de percursos de rápida "mudança emergente" orientada para o desenvolvimento.» Madrid: Universidade Complutense de Madrid. <http://eprints.ucm.es/12198/1/T32379.pdf>.

FINDELI, Alain. (1990). «Moholy-Nagy's Design Pedagogy in Chicago (1937-46)». *Design Issues* 7 (1): 419. doi:10.2307/1511466.

_____. (2001). «Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion». *Design Issues* 17 (1): 5–17. doi:10.1162/07479360152103796.

- FULTON SURI, Jane and MARSH, Matthew. (2000). «Scenario building as an ergonomics method in consumer product design». *Applied Ergonomics* 31 (2): 151–57. doi:10.1016/S0003-6870(99)00035-6.
- GUL, Leman F. (2009). «Studying the Impact of Immersion on Design Cognition». Em *Computation: The New Realm of Architectural Design: 27th eCAADe Conference Proceedings*, 615–22. Istanbul Technical University, Faculty of Architecture.
- GU, Ning, GUL, Leman F., WILLIAMS, Anthony. (2010). «Methods for evaluating 3D Virtual Worlds in Design Education». Em *International Design Conference - Design 2010*, 1259–66. Dubrovnik - Croatia.
- JOHNSON, L. et all. (2014). «MC Horizon Report - 2014 Higher Education Edition». Austin, Texas. <http://www.nmc.org/pdf/2014-nmc-horizon-report-he-EN.pdf>.
- JONES, Derek. (2013). «An Alternative (to) Reality». In *Understanding Learning in Virtual Worlds*, eds: Mark Childs e Anna Peachey. 1-20. New York: Springer.
- KNAUER, Roland. (2008). *Transformation. Basic Principles and Methodology of Design*. 1.ª ed. Birkhäuser GmbH.
- KVAN, Thomas. (2001). «The pedagogy of virtual design studios». *Automation in Construction*, CAADRIA, 10 (3): 345–53. doi:10.1016/S0926-5805(00)00051-0.
- LEE, Elinda Ai Lim. (2011). «An Investigation into the Effectiveness of Virtual Reality-Based Learning». Phd, Murdoch University. <http://researchrepository.murdoch.edu.au/4070/>.
- MALDONADO, Tomás. 1981. *El Diseño Industrial Reconsiderado*. Barcelona: Gustavo Gili.
- _____. (2012). «O corpo humano e o conhecimento digital». In *Cultura, Sociedade e Técnica*, pp. 119-150. Edgard Blucher.
- MARCOLLI, Attilio. (1971). *Teoria del Campo - corso di educazione alla visione*. 1998.ª, 17ª ed. Milano: Sansoni Editore.
- _____. (1978). *Teoria del Campo 2 - corso di metodologia dalla visione*. 1991, 3ª ed. Itália, Firenze: Sansoni Editore.
- MERCHANT, Zahira, et al. (2014). «Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis». *Computers & Education* 70 (Janeiro): 29–40. doi: 10.1016/j.compedu.2013.07.033.
- MONTEIRO, Ricardo and BARBOSA, Helena. (2014). «Challenges Game: um jogo dinamizador do processo de ensino». In *Atas do 2º Encontro sobre Jogos e Mobile Learning*, eds: Carvalho, A.A. et al, 74–84. Universidade do Minho. Instituto de Educação. Centro de Investigação em Educação (CIED).
- MUNARI, Bruno. (1979). *Arista e Designer*. Lisboa: Editorial Presença/Martins Fontes.
- _____. (1995). *Design e Comunicação Visual*. Lisboa: Edições 70.
- NARDI, Bonnie A. (1992). «The use of scenarios in design». *SIGCHI Bull* 24 (3): 13–14.
- PINK, Daniel. H. (2006). *A Whole New Mind: Why Right-Brainers Will Rule the Future*. Penguin.
- REBELO, Francisco. et al. (2011). «Virtual Reality in Consumer Product Design: Methods and Applications». In *Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques*, editado por Waldemar Karwowski, Marcelo M. Soares, e Neville A. Stanton, 381–402. CRC Press.
- SCHANK, Roger. (2011). *Teaching Minds: How Cognitive Science Can Save Our Schools*. Teachers College Press.
- SIK LÁNYI, Cecília, ed. (2012). *Applications of Virtual Reality*. InTech.
- SIK LÁNYI, Cecília, LÁNYI, Zsuzsanna and TILINGER, Ádám. (2003). «Using Virtual Reality to Improve Space and Depth Perception». *Journal of Information Technology Education* 2: 291–303.
- SORBY, Sheryl A. (1999). «Developing 3-D Spatial Visualization Skills». *Engineering Design Graphics Journal* 63 (2): 21-33. <http://diggingdeeper.pbworks.com/f/Developing+Spatial+Skills.pdf>.
- STEADMAN, Philip. (2008). *The Evolution of Designs: Biological Analogy in Architecture and the Applied Arts*. USA and Canada: Routledge.
- WONG, Wucius. (1995). *Fundamentos del diseño*. 4ª ed. Espanha, Barcelona: Gustavo Gili.



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Basic Design meets Virtual Reality: A tentative methodology

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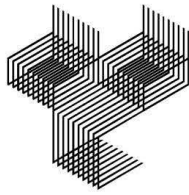
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Abstract

Basic Design is a discipline with a propaedeutic character, that usually takes place at the initial formative period of the design students. Despite its relevance, Basic Design remains an unexplored field regarding the impact of the new technologies (e.g., VR - Virtual Reality) in teaching-learning process, whose positive contributions are already well-known in multiple educational fields. Currently, a conventional (analogical) methodology is used at a Basic Design rooted discipline, named Laboratório de Design 3D, in IADE. In this context, we are conducting a research to explore the contribution of VR for enhancing the learning of Basic Design contents. Therefore, this paper presents the global methodological approach applied in the study and its underlying theory, with emphasis on the tools (e.g., questionnaires and virtual environments). Grounded on the Cognitive Flexibility Theory, two VR-based tools developed for the study will provide the opportunity to interact virtually with 3D structures. A quasi-experimental methodology will allow to compare two groups, consisting of 24 students each. The first group (i.e., control group) will use the non-digital conventional methodology (verbal and 2D images) while the second group (i.e., experimental group) will use a hybrid methodology (VR plus verbal and 2D). Results regarding the impact of the VR-based tools will be based on students perception of motivation and barriers to creativity expression, as well as their performance.

Keywords

Design Education, Basic Design, Virtual Reality, methodology approach



1 Introduction

The XXI century design students print a changing point into current teaching methodologies, which demands new learning environments and adequate teaching methods, prompting new pedagogical approaches (Gu, Gul, & Williams, 2010). At the core of design education programs, Basic Design remains one of its main components (Findeli, 2001; Boucharenc, 2006; Cetinkaya, 2014).

1.1 Basic Design

Basic Design discipline was born within Bauhaus School (1919-33), specifically addressing the initial formative period of the designer by promoting a holistic, creative and experimental methodology with respect to the fundamental principles of design. The pedagogy of Bauhaus emphasizes the human development, which Gropius and Itten brought to design education, influenced by Dewey, Montessori, Steiner, Piaget, Froebel, Pestalozzi and others (Fontoura, 2002). Constructivism Learning Theory, besides sharing with Basic Design its origin, reflect on the discipline the central idea of Piaget, that learning is built in the subject-object interaction, and Dewey's notion of "learning by doing". Internationally implemented and adapted to the present times (Cetinkaya, 2014), Basic Design develops more an attitude than a profession, being considered the best pedagogic tool for developing visual intelligence in the present century (Findeli, 2001).

1.2 Basic Design rooted discipline: Lab D3D

Grounded on Basic Design pedagogy, the currently adopted methodology at *Laboratório de Design 3D* (Lab D3D), was revised and updated by Fernandes (2013; 2011). With a broad frame of reference, Lab D3D corresponds to a cross propedeutic training to the three main design areas: graphic; product; and interior design. It aims the incorporation of an investigation method for complex systems generation that rely on student engagement in creation/construction of three-dimensional, hand scale, abstract forms, mainly using the hands. Functional aspects of the objects are not taken in consideration, as well as most components of a design project, including color and texture. The course focus the incorporation of design patterns, applied throughout the three exercises.

1.3 Virtual Reality as a learning improvement tool

Virtual Reality is characterized by enhancing the interaction, immersion and imagination, resulting in different levels of presence (Burdea & Coiffet, 2003). These factors, along with the degree of intrusion and discomfort caused by the devices (e.g., nausea, eyestrain, proficiency with navigation techniques) result in a variable degree of presence, which aims to be high. The presence can be defined as a convincing sense of being in the virtual world, allowing the evaluation of more advanced aspects of interaction, as behaviours or emotions, with good ecological validity (Rebelo, Duarte, Noriega, & Soares, 2011).

VR technology is currently used in a broad range of applications, such as games, movies, simulations, and a few main focus are training, education, collaborative work, therapy and learning (Lanyi, 2012). It is presently reinforced the growing importance of VR, either for abstract concepts learning, observation of phenomena at different scales, and participation in events so far impossible to witness, either for reasons of safety, costs, or distance (Abdelaziz, Riad, & Senousy, 2014). It is also acknowledged the impact of VR-based tools (e.g., games, simulations, virtual environments) for improving learning outcome gains, (Lee, 2011; Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014).

VR-based tools also promote learning transfer (Bossard, Kermarrec, Buche, & Tisseau, 2008) and encourage diverse ways of thinking through the observation from multiple perspectives (Lee, 2011).

1.3.1 VR technology for Lab D3D

Our pedagogical approach at Lab D3D faces the announced inevitability of VR presence in the future of design education (Colucci, 2011). However, the discipline remains unexplored regarding the application of new technologies (e.g., VR) in the teaching-learning process (Neves & Duarte, 2015). Considering the support of VR technology for phenomenon simulation, it could affect imagination and motivation of the students. Also VR-based tools can be positive for overcoming some difficulties noticed by the first year design students, such as the engagement in the manual tasks and the emotional connection with the abstract structures. The validation of this statement is the main goal of our study which will provide the means for assessing the impact of VR technology at Lab D3D. The specific objectives consist in developing and validating the experimental setup (i.e., facilities and equipment), the metrics, scales, tools and procedures for data collection.

1.4 Cognitive Flexibility Theory for VR-based tools, at Lab D3D

The Theory of Cognitive Flexibility is based on the Constructivist Learning Theory and deals with the acquisition of advanced level of knowledge in complex and ill-structured domains, as well as the transfer of knowledge to new situations (Carvalho, 2011). According to its authors, the learning process should create the opportunities for opening the range of possible uses of a concept, thereby, enabling its use in more different ways, consequently, affecting flexibility for solving new situations (Spiro, Feltovich, Jacobson, & Coulson, 1992).

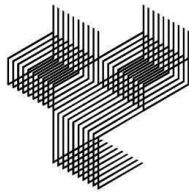
Supported by the Cognitive Flexibility Theory two VR-based tools present to the students new situations where the morphogenetic process and related concepts (already introduced in the first exercise) can be more deeply comprehended. These derive from Gui Bonsiepe's (1992) specific techniques applied in design practice and design learning: "*Formal synthesis – formal coherence creation*" and "*Controlled form creation processes*" (1992, p. 221).

2 Methodology

2.1 Quasi-experimental methodology

This research employs a quasi-experimental methodology, which is frequently adopted in educational settings, requiring no random selection of participants (Creswell 2013). Two first year classes from the design course, aged between 18 and 24 years old, are selected for a control group (24 students) and for an experimental group (35 students). In this sense, the first group doesn't use any of the VR-based tools, but a non-digital conventional methodology (verbal and 2D images). As to the second group, two different situations will apply VR. Therefore, a hybrid methodology (VR plus verbal/visual) is being used. It will be measured students perception of motivation and barriers to creativity, as well as their performance results on the exercises.

Two VR-based tools are developed for allowing free interaction with 3D abstract



structures in a semi-immersive environment. The students can move the structures and also walk around them as if they were physically present. Therefore the challenge can be understood at each one's own pace, according personal specific needs, using multiple perspectives and points of view. Also different materials, textures and light effects provide the feeling of real life conditions and interactions.

2.1.1 Stimuli

The main objective of Exercise 1 is to introduce the morphogenetic process for modularity and pattern creation using 2D form. This exercise has the purpose to level student's knowledge. Thus, no VR-based tool is administrated as long as it lasts.

Exercise 2 employs the same morphogenetic process for the generation/construction of one 3D modular system (i.e., three physical abstract structures) where aesthetic quality, diversity of effects and structural consistency are required. In this exercise a VR-based tool is developed. Six 3D structures are used, grouped according two modular systems. System 1 (structure A, B and C) and system 2 (structure C, D and F) can be manipulated by changing seven variables which are: scale; rotation; translocation; observer position; animation, material; and light. The details button reveal the characteristics of each structure according the theoretical concepts introduced in the first exercise. In the interaction with the structures, a pair of students explores the visual effects. There is no sound in the VE. The VE was a closed room, containing a single 3D structure positioned in the middle (fig.1 – right image).

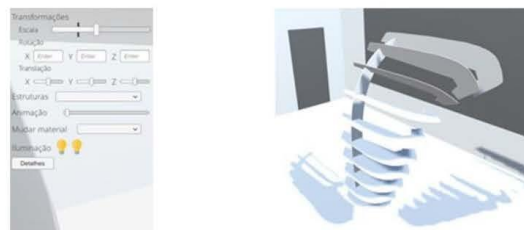


Figure 1. Interface of the VR-based tool (left image) and structure A, (right image).

Finally, Exercise 3 requires a single 3D structure which apply the already mentioned principles. However, the creation process will use, not a coupling of separated pieces, as the previous Exercise, but a single plan. During Exercise 3 a VR-based tool is used, similar to the previously mentioned VE. The main difference is the inclusion of different environments and the exploration of a single structure in each one of those.

2.1.2 Experimental Settings and Virtual Environment

An Acer H6510BD 3D Video Projector presents the VE (Virtual Environments) with the 3D prototypes. The structures are designed using 3D Max and then exported to Unity. nVIDIA (model 3D Vision2) shutter glasses is used to see the VE in stereoscopy and a camera to record each session. Students are free to visually explore the structures by manipulating it using a mouse. Pressing the left button of the mouse allowed to go around the structure. In order to change the scale, translation, rotation the interface on the VE is used (Fig 1 – left).

The projected image's size is 1.72m (horizontal) by 0.95m (vertical), with an aspect ratio of 16:9. The observation distance between the screen and the participant is 1.50 m,

resulting in a 35.2° of vertical field-of-view (FOV) and 59.7° horizontal FOV. Students remain seated during the experiment. The professor stands behind the students inside the room, which is darkened to prevent any external light interference.

2.2 Measures

2.2.1 Demographic questionnaire

In this questionnaire, demographic information (e.g., gender, age), a question about students' expectations regarding the discipline, and a final question about previous contact/interaction with Virtual Reality are asked.

2.2.2 Perceptions of Barriers to Personal Creativity Inventory

These questions intend to evaluate the perception of university students about the barriers that influence creativity expression. Through a 5-points Likert scale (1 "I completely disagree" to 5 "I completely agree"), 44 questions address the creativity barriers in four factors: emotional (14 questions); personal motivation (12 questions); time, opportunities and resources (10 questions); and social (8 question). This questionnaire was adapted and validated to Portuguese population (Morais, Almeida, Azevedo, Alencar, & Fleith, 2014).

2.2.3 Creativity level

A single question addressing the level of creativity perceived has the intention to complement the Perceptions of Barriers to Personal Creativity Inventory. It is asked in the beginning and at the end of the semester how creative students consider themselves.

2.2.4 Self-perception of Creativity and Motivation Inventory

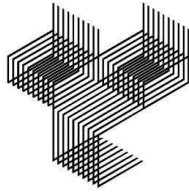
This questionnaire is based on the Perceptions of Barriers to Personal Creativity Inventory. Also, the questionnaire assesses motivation, according the Instructional Materials Motivation Survey (IMMS) (Keller, 2010). Following the ARCS model, as applied by Wei, Weng, Liu, & Wang (2015), the questionnaire includes 19 questions for motivation, in the four categories: attention (5 questions); relevance (4 questions); confidence (4 questions); and satisfaction (6 questions). With this inventory, we aim to assess student's perception of the barriers to creativity and motivation while performing the exercise. It used the same Likert scale from the previous questionnaire.

2.2.5 Performance

Students performance is analysed and assessed by a group of three independent researchers, experts in Basic Design. This evaluation follows the defined criteria for the discipline evaluation (i.e., technical, analytical and aesthetic capacity). Researchers analyse individually the exercise performed by each student and assign them a quantitative grade. In the end, the three researchers compare the grades assigned to each student. All discrepancies are discussed in order to achieve an agreement.

2.2.6 Video analysis

The procedure is video recorded for analysing students behavioural responses. The videos are watched individually by three independent researchers according a behavioural observation grid created for the study. This grid includes the number of times the students move towards the structures and/or try to grab them (due to 3D effect), verbal expressions, communication between the two students about the VR experience, and



questions during the presentation.

2.3 Procedures

A total of four moments are considered in the quasi-experiment: the characterization of the sample (1); the levelling of student's performance and perception of creativity and motivation (2); and measuring the impact of both VR-based tools (3) and (4) (Fig.3).

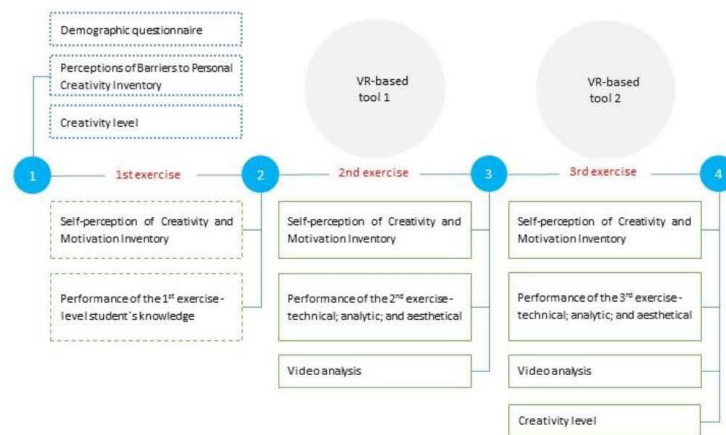


Figure 2. Scheme of the experimental procedure.

3 Final remarks

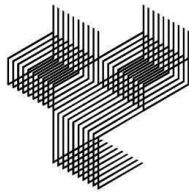
In order to explore the contribution of VR technology to Basic Design we defined a methodological approach which is presently being applied in the context of Lab D3D discipline. The first of those tools was already presented to the students, with the objective to introduce the second exercise of the semester. The second tool is being prepared and will be presented to the students in the course of the third exercise. The analysis of questionnaires, videos and the performance results of both second and third exercises will reveal the impact of the VR-based tool according a quasi-experiment approach. Two groups will be compared (i.e., the control group and the experimental group) on the perception of creativity barriers; perception of motivation; and performance. Results will be available by the end of the current semester.

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References

- Abdelaziz, M., Riad, A., & Senousy, M. B. (2014). Challenges and Issues in Building Virtual Reality-Based e-Learning System. *International Journal of E-Education, E-Business, E-Management and E-Learning*, 4(4), 320–328.
- Bonsiepe, G. (1992). *Teoria e prática do design industrial: elementos para um manual crítico* (1992–1ª ed portuguesa ed.). Lisboa: Centro Português de Design.
- Bossard, C., Kermarrec, G., Buche, C., & Tisseau, J. (2008). Transfer of learning in virtual environments: a new challenge? *Virtual Reality*, 12(3), 151–161. <http://doi.org/10.1007/s10055-008-0093-y>
- Boucharenc, C. G. (2006). Research on Basic Design Education: An International Survey. *International Journal of Technology and Design Education*, 16(1), 1–30. <http://doi.org/10.1007/s10798-005-2110-8>
- Burdea, G., & Coiffet, P. (2003). *Virtual Reality Technology* (2 ed). Hoboken, N.J:Wiley-IEEE Press.
- Carvalho, A. A. A. (2011). A teoria da flexibilidade cognitiva e o modelo múltiplas perspectivas. Retrieved from <http://repositorium.sdum.uminho.pt/handle/1822/15921>
- Cetinkaya, C. (2014). Basic Design Education Parameters in Turkey. In *Humanitas International Journal of Social Sciences* (pp. 31–46). Central and Eastern European Online Library.
- Colucci, K. (2011). What role will technology play in the future of design education. In *icograda Design Education Manifesto 2011* (pp. 63–67). Retrieved from http://toolkit.icograda.org/database/rte/files/PR_IEN_Manifesto2011_webres.pdf
- Creswell, J. W. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition* (4th edition). Thousand Oaks: SAGE Publications, Inc.
- Fernandes, R. (2011). *Design, Informação e Desenvolvimento: um contributo metodológico para a exploração do 'Potencial Informativo do Produto' como fator de percursos de rápida 'mudança emergente' orientada para o desenvolvimento*. Universidade Complutense de Madrid, Madrid.
- Fernandes, R. (2013). Programa da UC Design Tridimensional.
- Findeli, A. (2001). Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion. *Design Issues*, 17(1), 5–17. <http://doi.org/10.1162/07479360152103796>
- Fontoura, A. (2002). *EdaDe - A educação de jovens e crianças através do Design* (Doutoramento). Universidade Federal de Santa Catarina, Florianópolis, Brasil.



- Gu, N., Gul, L. F., & Williams, A. (2010). Methods for evaluating 3D Virtual Worlds in Design Education. In *International Design Conference - Design 2010* (pp. 1259–1266). Dubrovnik - Croatia.
- Keller, J. M. (2010). *Motivational Design for Learning and Performance*. Boston, MA: Springer US. Retrieved from <http://link.springer.com/10.1007/978-1-4419-1250-3>
- Lanyi, C. (Ed.). (2012). *Applications of Virtual Reality*. InTech.
- Lee, E. A. L. (2011). *An investigation into the effectiveness of virtual reality-based learning* (phd). Murdoch University. Retrieved from <http://researchrepository.murdoch.edu.au/4070/>
- Lerner, F. (2005). Foundations for Design Education: Continuing the Bauhaus Vorkurs Vision. *Studies in Art Education*, 46(3), 211–226.
- Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, 70, 29–40. <http://doi.org/10.1016/j.compedu.2013.07.033>
- Moraís, M. de F., Almeida, L. S., Azevedo, I., Alencar, E., & Fleith, D. (2014). Perceptions of barriers to personal creativity: validation of an inventory involving high education students. *The European Procedia Social and Behavioural Sciences Ep-SBS*, 135–145.
- Neves, A. G., & Duarte, E. (2015). Using Virtual Environments in Basic Design Education. In E. Duarte, C. Duarte, & F. Carvalho Rodrigues (Eds.), *Senses & Sensibility'15: Design as a Trade Proceedings of the UNIDCOM/IADE 8th International Conference* (pp. 273–280). Lisboa, Portugal: IADE - Creative University / Edições IADE.
- Rebelo, F., Duarte, E., Noriega, P., & Soares, M. M. (2011). Virtual Reality in Consumer Product Design: Methods and Applications. In Waldemar Karwowski, Marcelo M. Soares, & Neville A. Stanton (Eds.), *Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques* (pp. 381–402). CRC Press.
- Spiro, R., Feltovich, P., Jacobson, M. J., & Coulson, R. (1992). Knowledge Representation, Content specification, and the Development of Skill in Situation Specific Knowledge Assembly: Some Constructivist Issues as They relate to Cognitive Flexibility Theory and Hypertext. In T. M. Duffy & D. H. Jonassen (Eds.), *Constructivism and the Technology of Instruction: A Conversation* (pp. 121–128). Routledge.
- Wei, X., Weng, D., Liu, Y., & Wang, Y. (2015). Teaching based on augmented reality for a technical creative design course. *Computers & Education*, 81, 221–234. <http://doi.org/10.1016/j.compedu.2014.10.017>

LEARNING BASIC DESIGN WITH VIRTUAL REALITY: A METHODOLOGICAL APPROACH

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Abstract

Basic Design remains an unexplored field regarding the input of the new technologies (e.g., Virtual Reality - VR) in teaching-learning process. Currently, a conventional (i.e., analogical) methodology is being used to teach Basic Design, at "Laboratório de Design 3D" curricular unit, in a Portuguese design university. In this context, a research study is being conducted to assess the potentialities of VR as a pedagogical tool for learning Basic Design contents. This paper presents the methodological approach applied in the study and its theoretical framework. Grounded on the Cognitive Flexibility Theory, a VR-based tool is being developed, intended to provide students the opportunity to interact with 3D structures. A quasi-experimental methodology is being used to compare two groups of students (control and experimental) in which the control group is exposed to a conventional teaching method (i.e., verbal and static pictures) and the experimental group to a hybrid method (i.e., verbal and VR-based tool). The influence of the VR-based tool will be measured based on the student's performance, their creativity and motivation, and on their perceptions of barriers to personal creativity.

Keywords: Design Education; Basic Design; Virtual Reality; Methodology.

1 INTRODUCTION

Due to the digital technologies advent, current generations of design students constantly expect new teaching methodologies that, in turn, demand new learning environments and adequate teaching methods, prompting new pedagogical approaches [1]. Since Basic Design is one of the main components in design education [2], [3], [4], [5], new approaches should be expected in this discipline too.

Basic Design was born at Bauhaus School (1919-33) as a discipline that addresses the initial formative period of the designer by promoting a holistic, creative and experimental methodology with respect to fundamental principles of design. It helps to develop an attitude more than professional skills, built on the dichotomic pedagogical principle of "intuition and method" or "subjective experience and objective recognition" [6]. Despite the many changes occurred since the beginning of its existence, Basic Design is internationally implemented and adapted to the present times [5], being considered the best pedagogic approach for developing visual intelligence in the present century [2]. Characteristics of the aesthetic and formal exercises are dependent from the exploration of colour, composition and texture, though, most of the technical and physical factors are not taken into account (e.g., materials, ergonomics, costs, manufacturing processes and the function) [7].

Rooted in Basic Design, the methodology currently adopted at the *Laboratório de Design 3D* (Lab D3D) discipline, which has been taught in IADE, was revised and updated by Fernandes [8], [9]. The discipline corresponds to a cross propaedeutic training to three main project areas: graphic, product and interior design. It aims the incorporation of a process for generating complex systems by recursively applying trial and error while promoting students' engagement in creating three-dimensional (3D), hand scale, abstract forms, mainly by using hand skills.

Functional aspects of the objects, as well as many other constraints of a design project (e.g., technical and physical factors of the materials, ergonomics, costs, manufacturing processes), are not taken into account. Some of the design variables (e.g., colour and texture) are also excluded from the program of Lab D3D. The discipline focuses on developing a sensitivity to the technological and aesthetic phenomena and projectual ability [7, p. 77], over the incorporation of design patterns: field structure; reference mark; elementary parts; elementary motif; combinatorial; modularity; patterning; symmetry/asymmetry; formal coherence; structural consistency; systemic; complexity; simplicity; maximum diversity with the minimum repertoire; among others. Accordingly to the currently adopted program,

these concepts are repeated throughout three exercises. Nevertheless, it can be seen that Lab D3D remains an unexplored discipline regarding the application of new technologies (e.g., Virtual Reality - VR) in the teaching-learning process [10].

VR involves the use of 3D synthetic worlds (i.e., virtual environments - VEs) that can allow the users to experience the artificial phenomenon with the quality and intensity once thought to be unique of real life. To be able to provide such an experience, a high sense of presence (i.e., the sense of being there, inside the VE) is required. Thus, according to the Triangle of VR proposed by Burdea and Coiffet [11], the computer-based simulation can be classified according to its ability to provide the user levels of: immersion (i.e., isolation from the real-world stimulus); interaction (e.g., immediate/ real-time reactions/ behaviours of the virtual objects in response to the user's actions); and imagination (depending mostly on the participants and their willingness to be deceived, but also from the quality of the narrative / storytelling presented). Other factors are also known as playing a role on the sense of presence, such as the number of human senses being stimulated, and the VR induced symptoms and effects (e.g., nausea, eye fatigue, disorientation) [12]. A combination of all these factors can be used to characterize the VR simulation in the so-called "Virtual Continuum" [13], which is a line that spans from the real-world environment to a pure virtual environment, with Augmented Reality (closer to the real environment) and Augmented Virtuality (closer to the virtual environment), in-between.

When compared with other systems using VEs, the immersive VR systems (e.g., using head-mounted displays or CAVE) can facilitate the evaluation of more advanced aspects of interaction with the world, as behaviours or emotional responses with good ecological validity (e.g., [14]). To assess perceptions of space, shape, size, and among others, non-immersive desktop VEs may be sufficient, in which the environments or objects are generated and displayed by 3D modelling software (e.g., 3D Studio Max; Sketchup Pro).

Currently, VR technology is used in a broad range of scopes, such as entertainment (e.g., games, movies), education and training (e.g., simulations, serious games), collaborative work, and therapy [15]. The technology allows the generation of phenomena, alternative experiences to reality, enabling some of today's most innovative pedagogical approaches [16]. However, its potential is yet to be unveiled [17]. In this sense, the importance of VR in the learning context is reinforced in which facilitates learning abstract concepts [18]. Previous studies on education suggest that VR improves learning outcomes and has positive effect on the cognitive and affective domains of the learners [19], [20]. VR can also be used to promote the transfer of learning [21] by adding the encouragement of diverse ways of thinking through the observation from multiple perspectives [20, p. 2].

The Theory of Cognitive Flexibility is based on the constructivist learning theory and deals with the acquisition of advanced level of knowledge in complex and little-structured domains, as well as the transfer of knowledge to new situations [22]. Thus, according to its authors, the learning process should create the opportunities for opening the range of possible uses of a concept. This would enable its use in more different ways and, consequently, affecting flexibility for solving new situations [23].

Despite the well-known benefits of VR in the learning process, the pedagogical approach in Lab D3D is still based on a conventional non digital methodology that mostly relies on hand skills. Thus, in this study, and supported by the Cognitive Flexibility Theory, two semi-immersive VR-based tools (3D wall screen projection) are being developed, aiming to present the students new situations where the morphogenetic process and related concepts (already introduced in previous exercises) can be perceived and comprehended. This paper presents a VR-based methodology that can contribute to Basic Design education.

2 METHODOLOGY

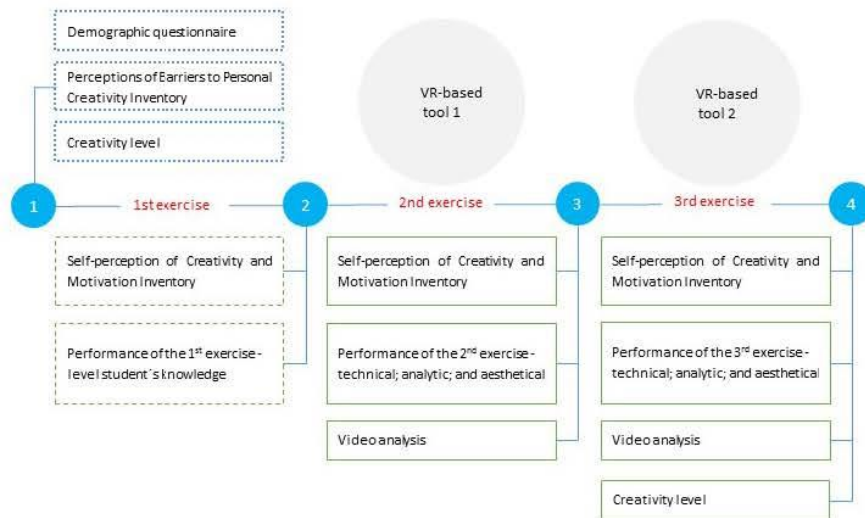
2.1 Participants

Two groups of students (i.e., a control group and an experimental group) were considered, aged between 18 and 24 years old. The groups present homogeneous distributions of age and gender (i.e., the experimental group has 12 male and 23 female; and the control group, 10 male and 13 female. Students are also levelled in terms of performance knowledge, since the first exercise serves this purpose. The control group is exposed to a conventional method (i.e., verbal and static pictures) whereas the experimental group is exposed to a hybrid method (i.e., verbal and VR-based tool).

2.2 Design of the study

This study employs a quasi-experimental methodology, which is frequently adopted in educational settings, requiring no random selection of participants [24]. Similar approaches have been applied to evaluate the effects of the VR-based instructions on K-12 and higher education settings, using also a learning outcome measure [19].

This study uses a mixed design, in which the groups (control group vs. experimental group) are the between-subjects factor and the exercises the within-subjects factor. The dependent variables are Perception of Barriers to Personal Creativity Inventory, Creativity Level, Self-perception of Creativity and Motivation Inventory and Performance which are explained in the next topic - Stimuli. The study flow-chart (Figure 1) depicts the sequence of phases/exercises and the measures gathered.



"Fig. 1" Design of the study

2.3 Stimuli

Three exercises are given for one semester which apply a learning by doing process. Each one requires mastering a medium, i.e. technical competency for creativity expression and aesthetic quality. All exercises are solved individually and each one takes five weeks (6 hours per week) to accomplish. The briefings for each exercise are presented to the students every five week period, which are complemented with verbal general orientations and visual examples commented by all. The details are highlighted along the five week practice in feedback moments.

With a growing level of complexity, the exercises aim the development of a morphogenetic creation process with formal coherence: in the Exercise 1 and 2 from parts to totalities, in the Exercise 3, the totality of the form is first explored and then, the methodological process determines its constitutive elements. The evaluation of the exercises reflects the increasing of complexity, each one assessed in three categories of competences: technique, analytic and aesthetic. At the end of each exercise, a visual analysis of the whole process is requested. Complementarily, a practical examination is required for assessing the performance in Exercise 1, and posters and/or videos for the Exercises 2 and 3. All exercises require no pre-concept but, instead, and along the whole procedure, the aesthetic features and qualities of the volumes afford suggestions for different possible uses in the social-cultural context, highlighting for this purpose, what could be, what could do and how could it do, in different contexts and scales.

2.3.1 Exercise 1

The main objective of Exercise 1 is to introduce the morphogenetic process for modularity and pattern creation using 2D form generation. Two modular systems are created, which apply the process for formal coherence [7] and the principle for maximum diversity with the minimum repertoire, among others.

Material. In the first moment, pencil and ruler for drawing the grid in A3 format paper are required; and after, two markers with different thickness for drawing in A3 tracing paper.

Measures and Procedure. Five measures are assessed in this exercise, which are:

(i) *Demographic questionnaire:* Demographic information (e.g., gender, age), students expectations regarding the discipline, previous contact/interaction with VR are gathered.

(ii) *Perceptions of Barriers to Personal Creativity Inventory:* This questionnaire evaluates the perception of university students about the barriers that influence the expression of creativity through a 5-points Likert scale (1 "I completely disagree" to 5 "I completely agree"). 44 questions assess the barriers to creativity in four factors: emotional (14 questions), personal motivation (12 questions), time, opportunities and resources (10 questions), and social (8 question). This questionnaire was adapted and validated to Portuguese population [25].

(iii) *Creativity level:* This part is about self-perceived level of creativity, according to a 5-points Likert scale (1 "not creative" to 5 "extremely creative").

(iv) *Self-perception of Creativity and Motivation Inventory:* This questionnaire is based on the Perceptions of Barriers to Personal Creativity Inventory and also, the Instructional Materials Motivation Survey (IMMS) [26]. It includes 44 questions for perceived creativity barriers and 19 questions for motivation according to the motivational design categories from ARCS model (i.e., Attention, Relevance, Confidence and Satisfaction) as applied in the studies of Cruz [27] and just used by Wei, Weng, Liu, and Wang [28]. The questions for motivation are included in the following categories: attention (5 questions for attention, curiosity and interest); relevance (4 questions connected to the perceived relation between the challenge value and the value attributed to the learning); confidence (4 questions related to the believe in the ability to achieve the goals with success); and satisfaction (6 questions addressing the demonstration of satisfaction when expectations regarding the learning outcome are confirmed). With this inventory, it is aimed to assess student's perception of the barriers to creativity and motivation while performing the exercise. The same Likert scale from the questionnaire Perceptions of Barriers to Personal Creativity Inventory is used.

(v) *Performance:* Students' performance is analysed and assessed by a jury of three professors, experts in Basic Design. This evaluation is conducted based on the defined criteria used for the global discipline evaluation (i.e., technical, analytical and aesthetic capacity). To this end, each professor analyses individually the exercise performed by each student and assign a quantitative grade to each one. Finally, the juries compare and discuss the results to reach consensus in case of discrepancies.

The following measures are given before Exercise 1: Demographic Questionnaire; Perceptions of Barriers to Personal Creativity Inventory; and Creativity Level. After completing the exercise and grades are revealed, Self-Perception of Creativity and Motivation Inventory, and also Performance, are collected.

2.3.2 Exercise 2

The objective of this exercise is the development of one 3D modular system where the aesthetic quality and the diversity of visual effects should be valued, as well as the structural consistency of the physical models. Using the same morphogenetic process and principles applied in the first exercise, three abstract structures (i.e., three elementary motifs) should be created using the same elementary part (i.e., an asymmetric 2D form previously chosen) placed in a sequential order. Each sequence brings out a visual effects/ volume, for which the previously learned concepts (i.e., sameness classes and symmetry operations) help to foresee the adequate geometrical-mathematical procedures (i.e., distances and angles).

Material. Only in the experimental group, a VR-based tool is used to explain the exercise. All the students, regardless of the group they are assigned to, use K-line and craft knife for building the final 3D structures, which required, in previous moments, cardboard and drawing materials.

Measures and Procedure. The measures that are used in this exercise are Self-perception of Creativity and Motivation Inventory, Behaviour and Interaction (to be made by video analysis), and Performance.

(vi) *Behaviour and Interaction:* During the procedure, the students behavioural reactions to the structures presented in VR are video recorded, for post-experiment analyses. The videos are seen individually and analysed according to a behavioural observation grid created for the study. The analysis of behaviours grid allow the register of student's verbal reactions; gestural reactions; comments between students; and doubts relating the exercise.

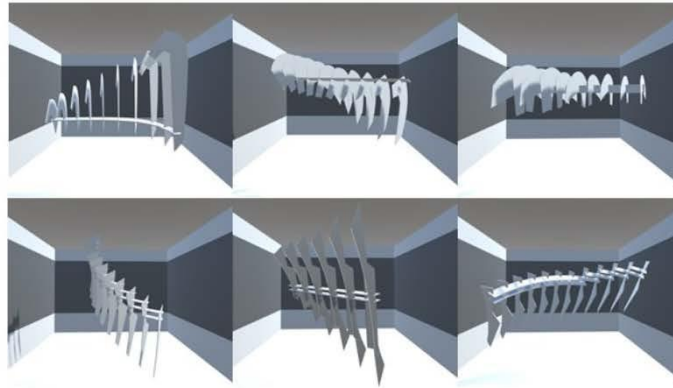
The briefing is presented and a VR-based tool is used to introduce the objectives, procedures and materials along one class. Using a semi-immersive environment, the professor explains the exercise while the students interact with the abstract structures from a 3D modular system, like the ones they are required to create. They can move the structures and also walk around them as if they were physically present. The challenge can be understood at each one's own pace, according to their personal specific needs. Thus, the experience is intended to afford an easy shifting between different structures, multiple perspectives and points of view, and also different materials, textures and light effects. Two of those structures have animations for evidencing two important aspects of the exercise; i.e., the different possible forms of the connecting element; and the fittings between all the parts. The conventional methodology used for introducing the second exercise to the control group includes verbal explanations and static pictures of some 3D abstract structures made by former 1st year students.

Students are invited to participate in a class lectured in a different space, the VR Lab. Upon arrival, they are given a brief explanation about the purpose of the study and asked to sign an informed consent form. Also, they are told that the entire procedure will be video recorded, for post-experiment analyses of behavioural reactions to VR simulation. After, in pairs, they seat in front of the wall screen and are asked to wear the 3D shutter glasses. Once they declare they are ready, the professor gives a general briefing about how to use the tool and explains them the exercise (e.g., objectives, procedures and materials). The students are incentivised to follow the professor's introductory explanations while exploring the VR-based tool displayed on the screen "Fig. 2". At the end, the students are thanked, debriefed and dismissed. The total duration of the experiment is around 10 minutes. Self-perception of Creativity and Motivation Inventory are collected, as well as Performance, right after the exercise is complete and the grades are revealed. Also Behaviour and Interaction will be gathered.



"Fig. 2" Students exploring the VE

VE. For this exercise, the VE is a closed room containing each structure positioned in the middle of the room. No sound was added to the VE. In order to facilitate the identification of the structures, each one was associated to a letter from A to F. Six 3D structures are used, as depicted in "Fig. 3", grouped according two modular systems, each one using a different elementary part. Both systems could be manipulated by changing seven variables, which are: scale; rotation; translocation; observer position; animation; material; and light. The details of each system can be viewed at any time, revealing the characteristics of the structures according the theoretical concepts already introduced during the first exercise.



"Fig. 3" Screen shots of the VE exhibiting the 3D structures used during the procedure

Experimental Settings. An Acer H6510BD 3D Video Projector displays the VEs and the structures that are designed using 3D Max and then exported to Unity. nVIDIA (model 3D Vision2) shutter glasses are used to see the VEs in stereoscopy and a video camera is used to record each session. Students are free to visually explore the VE by using a mouse. Pressing the left button of the mouse allowed moving around the structure. The exploration of the structures and the modifications in variables such as the scale, translation, and rotation could be done using the mouse over a control panel on the VE (as can be seen in "Fig 4").



"Fig. 4" Control panel in the VE interface

2.3.3 Exercise 3

In the Exercise 3, a single structure is required, for which the aesthetic quality and structural consistency persist as main objectives. However, the creation process will use, not a coupling of separated pieces, but a single plan that origins a volume with structural consistency by cutting, bending, folding and fitting contiguous/adjacent figures.

Materials: A second VR-based tool is also used in the experimental group during the concept creation process. Polypropylene is the material selected to construct the 3D structure, to be created in the end of the exercise by both groups. However, other materials, such as paper/ cardboard, adhesive tape, besides drawing and cutting materials are also required for exploring the concept.

Measures and Procedure. The measures that are used in this exercise are Self-perception of Creativity and Motivation Inventory, Behaviour and Interaction (to be made by video analysis), Performance and Creativity Level.

The exercise briefing is introduced and, during the concept creation, a new VR-based tool is presented. Along one class, the students can explore individually the structures that were developed until that moment, in different and changeable contexts of use. In this sense, the 3D objects will be tested in different situations, preserving the richness and complexity that usually occur during real phenomenon interactions.

Both physical prototypes and virtual prototypes are used in design activities for the validation of the visual/haptic interaction approach [29]. Thus, exposure to different scenarios will allow potential users to present their ideas and/or questions about the interaction with the concepts of a product, in existing or future contexts. These scenarios can be used in various stages of development of a product and can serve to understand their features, develop attributes of a product or assess user behaviours in critical situations of interaction with a product or system (e.g., exposure to hazardous situations and/or costly events).

At the end of the exercise, after grades are revealed, Self-perception of Creativity and Motivation Inventory are collected, as well as Performance and Behaviour and Interaction. At this moment also Creativity Level is gathered.

Experimental Settings. Same as Exercise 2.

VE. Students' own designs are shown in three different VEs using scenarios that vary from a private indoor space; a semi-public indoor space; and a public exterior/ outdoor space. Structures with different scales are used accordingly each one of those spaces, respectively: living room (smallest scale); art gallery (medium scale); and garden (biggest scale). The same interface will be used, allowing the manipulation of the variables, which are: scale; rotation; translocation; observer position; material; light; and two positions for the camera (i.e., interior and exterior cameras).

3 CONCLUSIONS

The objective of this paper was to present a VR-Based methodology, for which two VR tools were created, intended to contribute to innovate Basic Design education. The study is being conducted in Laboratório de Design 3D discipline at IADE, a Portuguese Design University, in 2016 Spring semester.

It is expected that the VR-based tools can help overcoming some difficulties noticed by the first year design students, such as the low engagement in the manual tasks and the poor emotional connection with the abstract structures. The validation of this statement is the main goal of the methodology which will provide the means for assessing the impact of VR technology in the discipline, specifically collecting the students' perceptions of barriers to personal creativity, creativity level, self-perception of creativity and motivation as well as their performance.

Although the experiments are still preliminary, we are already in position to derive some reflections about the constraints noticed so far, and to consider some possible limitations of the study, as well as possible contributions for next studies.

Technical occurrences: As a typical basic design professor doesn't normally have competencies on computer graphics or computer sciences, it should be noticed the need of constant support from a computer engineer during all the phases of the VR-based tool conception process and data collection. The number and the timing of the technological occurrences are difficult to foresee, which can jeopardize a whole class day for the students, requiring a careful planning.

Limited interaction: Despite the "wow" moment, video recorded during students' first interactions with the VR tool, a mouse and a keyboard restricted students' natural movements. This fact can be limiting their performance results and negatively affecting other measures, including the sense of presence and engagement, specially, when considering the importance of the proprioception in the learning process, whether for developing Lab D3D required expressive capacities [10] or for the renewed features of Basic Design synesthesia [30].

The short time for the interaction with the VE was also due to the restricted number of 3D glasses and other equipment available, thereby impeding multi-users sharing activities and a repeated access to the tool, if required. In this case, fully immersive solutions with HDM (Head Mounted Displays) and/or

Internet-based, soon available off-the-shelf, can make a difference in the potentialities of these tools. Certainly it will affect the quality of the interactions in VR-based learning experiences, possibly also connected with gamification strategies, mobile and/or e-learning principles.

Proficiency with technology. Previous training on 3D computer graphics and digital modelling software may be needed to establish the basic requirements for the first year design student's participation. A poor proficiency with such tools can narrow the potential of the second VR-based tool during Exercise 3, which intends to be used for anticipating the visual effects of each student concept creation, in different contexts and scenarios. Thus, enabling digital 3D skills to the newly arrived design students is desirable.

Finally, the presented ideas lead to our last and provoking thought, which is the possibility of transferring the entire conception process used at Lab D3D to the digital medium. Would it be possible, with the right support of VR technology, to eliminate the manual component of the Basic Design discipline? Inevitably, it requires for uncovering its advantages and disadvantages, for which the presented methodological approach can be a starting point.

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REFERENCES

- [1] Gu, N., Gul, L. F., & Williams, A. (2010). Methods for evaluating 3D Virtual Worlds in Design Education. In *International Design Conference - Design 2010* (pp. 1259–1266). Dubrovnik - Croatia
- [2] Findeli, A. (2001). Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion. *Design Issues*, 17(1), 5–17. <http://doi.org/10.1162/07479360152103796>
- [3] Boucharenc, C. G. (2006). Research on Basic Design Education: An International Survey. *International Journal of Technology and Design Education*, 16(1), 1–30. <http://doi.org/10.1007/s10798-005-2110-8>
- [4] Anceschi, G. (2010). Design di base: fundamenta del design. *Il Verri 'newbasic'*, (43). Retrieved from <http://www.ilverri.it/index.php/la-rivista-del-verri/edizione-dal-1996/newbasic-detail>
- [5] Cetinkaya, C. (2014). Basic Design Education Parameters in Turkey. In *Humanitas International Journal of Social Sciences* (pp. 31–46). Central and Eastern European Online Library.
- [6] Droste, M. (1992). *Bauhaus 1919-1933*. Alemanha: Taschen.
- [7] Bonsiepe, G. (2012). *Design como Prática de Projeto*. Brasil, S. Paulo: Edgard Blucher.
- [8] Fernandes, R. (2011). *Design, Informação e Desenvolvimento: um contributo metodológico para a exploração do 'Potencial Informativo do Produto' como fator de percursos de rápida 'mudança emergente' orientada para o desenvolvimento*. Universidade Complutense de Madrid, Madrid.
- [9] Fernandes, R. (2013). Programa da UC Design Tridimensional.
- [10] Neves, A. G., & Duarte, E. (2015). Using Virtual Environments in Basic Design Education. In E. Duarte, C. Duarte, & F. Carvalho Rodrigues (Eds.), *Senses & Sensibility'15: Design as a Trade Proceedings of the UNIDCOM/IADE 8th International Conference* (pp. 273–280). Lisboa, Portugal: IADE - Creative University / Edições IADE.
- [11] Burdea, G. C., & Coiffet, P. (2003). *Virtual Reality Technology* (2 edition). Hoboken, N.J: Wiley-IEEE Press.
- [12] Sharples, S., Cobb, S., Moody, A., & Wilson, J. R. (2008). Virtual reality induced symptoms and effects (VRISE): Comparison of head mounted display (HMD), desktop and projection display systems. *Displays*, 29(2), 58–69. <http://doi.org/10.1016/j.displa.2007.09.005>

- [13] Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1995). Augmented Reality: A class of displays on the reality-virtuality continuum. In *Proc. SPIE 2351, Telemanipulator and Telepresence Technologies*. <http://doi.org/10.1117/12.197321>
- [14] Rebelo, F., Duarte, E., Noriega, P., & Soares, M. M. (2011). Virtual Reality in Consumer Product Design: Methods and Applications. In Waldemar Karwowski, Marcelo M. Soares, & Neville A. Stanton (Eds.), *Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques* (pp. 381–402). CRC Press.
- [15] Lanyi, C. (Ed.). (2012). *Applications of Virtual Reality*. InTech.
- [16] Schank, R. C. (2011). *Teaching Minds: How Cognitive Science Can Save Our Schools*. Teachers College Press.
- [17] Jones, D. (2013). An Alternative (to) Reality. In M. Childs & A. Peachey (Eds.), *Understanding Learning in Virtual Worlds* (pp. 1–20). New York: Springer.
- [18] Abdelaziz, M., Riad, A., & Senousy, M. B. (2014). Challenges and Issues in Building Virtual Reality-Based e-Learning System. *International Journal of E-Education, E-Business, E-Management and E-Learning*, 4(4), 320–328.
- [19] Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, 70, 29–40. <http://doi.org/10.1016/j.compedu.2013.07.033>
- [20] Lee, E. A. L. (2011). *An investigation into the effectiveness of virtual reality-based learning* (phd). Murdoch University. Retrieved from <http://researchrepository.murdoch.edu.au/4070/>
- [21] Bossard, C., Kermarrec, G., Buche, C., & Tisseau, J. (2008). Transfer of learning in virtual environments: a new challenge? *Virtual Reality*, 12(3), 151–161. <http://doi.org/10.1007/s10055-008-0093-y>
- [22] Carvalho, A. A. A. (2011). A teoria da flexibilidade cognitiva e o modelo múltiplas perspectivas. Retrieved from <http://repositorium.sdum.uminho.pt/handle/1822/15921>
- [23] Spiro, R. J., Collins, B. P., & Ramchandran, A. R. (2007). Modes of Openness and Flexibility in Cognitive Flexibility Hypertext Learning Environments. In B. H. Khan (Ed.), *Flexible Learning in an Information Society*. USA: Idea Group Inc (IGI).
- [24] Creswell, J. W. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition* (4th edition). Thousand Oaks: SAGE Publications, Inc.
- [25] Moraes, M. de F., Almeida, L. S., Azevedo, I., Alencar, E., & Fleith, D. (2014). Inventory of barriers to personal creativity : a validation study involving university students. In *The European Procedia Social and Behavioural Sciences Ep-SBS* (pp. 135–146). Mersin, Turquia. <http://doi.org/10.15405/epsbs.2014.05.16>
- [26] Keller, J. M. (2010). *Motivational Design for Learning and Performance*. Boston, MA: Springer US. Retrieved from <http://link.springer.com/10.1007/978-1-4419-1250-3>
- [27] Cruz, S. (2010). Proposta de um modelo de integração das tecnologias de informação e comunicação nas práticas lectivas : o aluno de consumidor crítico a produtor de informação online. Retrieved from <http://repositorium.sdum.uminho.pt/handle/1822/10678>
- [28] Wei, X., Weng, D., Liu, Y., & Wang, Y. (2015). Teaching based on augmented reality for a technical creative design course. *Computers & Education*, 81, 221–234. <http://doi.org/10.1016/j.compedu.2014.10.017>
- [29] Bordegoni, M., Ferrise, F., & Cugini, U. (2013). Development of Virtual Prototypes Based on Visuo/Tactile Interaction for the Preliminary Evaluation of Consumer Products Usage. In A. Chakrabarti (Ed.), *CIRP Design 2012* (pp. 149–158). Springer London. Retrieved from http://link.springer.com/chapter/10.1007/978-1-4471-4507-3_15
- [30] Guerini, S. (2001). *Il Corpo Risponde. Le sinestesie nella didattica multimediale_Silvia Guerini* (licenciatura). Politecnico di Milano, Milão, Itália. Retrieved from https://issuu.com/silviaguerini/docs/il_corpo_risponde_silvia_guerini_ca

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Basic Design meets Virtual Reality: A tentative methodology

abstract

Basic Design remains an unexplored field regarding the input of the new technologies (e.g., Virtual Reality - VR) in teaching-learning process. The present study aims to assess the contribution of Virtual Reality in the learning of Basic Design topics. A quasi-experimental methodology, with a mixed design is being used, with two conditions: a conventional teaching method (i.e., verbal and static pictures) and a hybrid method (i.e., verbal and VR-based tool). A sample of sixty students, from "Laboratório de Design 3D" curricular unit, at IADE-U, assigned to one condition, rate their performance, creativity and motivation, as well as their perceptions of barriers to personal creativity. Currently we are developing, in a pilot study, the VR tools and the questionnaires for data collection and we expect to run the experiment next semester.

DEVELOPMENT

Basic Design discipline was born at Bauhaus School (1919-33) and despite the many changes occurred since then, it is internationally implemented and adapted to the present times (Findeli, 2001; Boucharenc, 2006; Cetinkaya, 2014). The discipline has a propaedeutic character and addresses the initial formative period of the designer by promoting a holistic, creative and experimen-

tal methodology with respect to fundamental principles of design.

Laboratório de Design 3D (Lab D3D) is a discipline lectured at the first year design course, at IADE-U. Systematized by Fernandes (2011), Lab D3D is rooted on Basic Design an introduces students to the 3D morphogenetic process. Three exercises are developed which apply a learning by doing process within the creation of ab-

stract, hand scale and manually crafted structures.

Virtual Reality (VR) involves the use of 3D synthetic worlds (i.e., virtual environments - VEs) that can allow the users to experience the artificial phenomenon with the quality and intensity once thought to be unique of real life.

VR enables some of today's most innovative pedagogical approaches (Schank, 2011). In this context is continually rein-

forced the importance of VR for learning and specifically for design education it was stressed its inevitability (Colucci, 2011).

Two VR-based tools are being developed to provide students the opportunity to interact with 3D structures (Fig.1). Accordingly, VR-based tool 1 is used for introducing Exercise 2 (Fig.2) and during Exercise 3, VR-based tool 2 presents different contexts for testing the abstract structures created by each student (Fig.3).

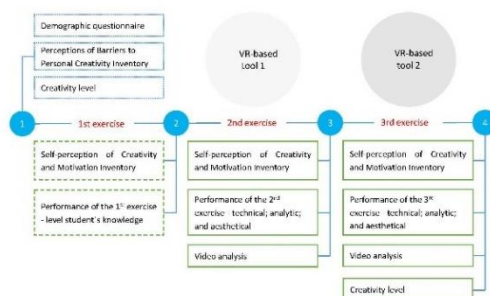


Figure 1 Design of the study

FINAL REMARKS

- It is expected that the VR-based tools can help overcoming some difficulties noticed by the first year design students, such as the low engagement in the manual tasks and the poor emotional connection with the abstract structures.
- Conclusions of the pilot study, by the end of the semester, will allow to improve the metrics, scales, tools and procedures for future data collection.
- Due the lack of student's digital literacy the use of VR-based tool 2 could be limited since it requires the use of a 3D software for modelling the abstract structures previously created according the conventional method.

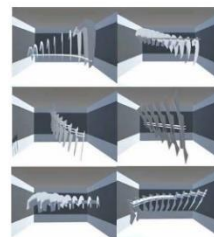
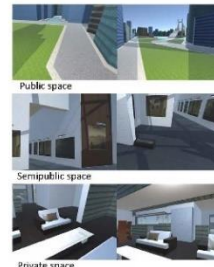


Figure 2 (above) and Figure 3 (below)



REFERENCES

- Boucharenc, C. G. (2006). Research on Basic Design Education: An International Survey. *International Journal of Technology and Design Education*, 16(1), 1-30. <http://doi.org/10.1007/s10798-005-2110-8>
- Cetinkaya, C. (2014). Basic Design Education Parameters in Turkey. In *Humanities International Journal of Social Sciences* (pp. 31-46). Central and Eastern European Online Library.
- Colucci, K. (2011). What role will technology play in the future of design education. In *Ioegrada Design Education Manifesto 2011* (pp. 63-67). Retrieved from http://toolkit.ioegrada.org/database/te/files/PR_IEN_Manifesto2011_webres.pdf
- Fernandes, R. (2011). Design, Informação e Desenvolvimento: um contributo metodológico para a exploração do 'Potencial Informativo do Produto' como fator de percursos de rápida 'mudança emergente' orientada para o desenvolvimento. Univ. Complutense de Madrid, Madrid.
- Findeli, A. (2001). Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion. *Design Issues*, 17(1), 5-17. <http://doi.org/10.1162/07479360152103796>
- Schank, R. C. (2011). *Teaching Minds: How Cognitive Science Can Save Our Schools*. Teachers College Press.



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The impact of a Virtual Reality-based tool on a Basic Design rooted discipline: Early perceptions

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Abstract

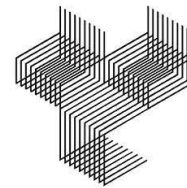
This paper presents the results of a pilot study conducted in a Basic Design rooted discipline named Laboratório de Design 3D, in IADE's graduation in Design. This was part of a larger on going study intending to develop a VR-based tool for teaching and learning Basic Design topics. The objective of this pilot was to test the tools and procedures prepared to assess the impact of the VR tool on students. Self-Perceptions of creativity and motivation were measured, as well as the student's performance. Early results suggest positive contributions of the VR tool. Observations of the video recorded sessions reveal enthusiastic reactions from the students, whether in engaging moments of discussion about the exercise, or while exploring the abstract structures in different scenarios. However, difficulties related with the implementation of the procedure during the semester were noticed, urging modifications.

Keywords

Design education; Basic Design; Virtual Reality

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1 Introduction

1.1 Basic Design

Basic Design remains one of the most important disciplines for Design Courses around the world (Anceschi, 2010; Boucharenc, 2006; Cetinkaya, 2014; Findeli, 2001). Created in 1919, Basic Design's pedagogical approach consists in introducing the beginning design students to the design fundamentals, using an experimental, creative, holistic and learning by doing method.

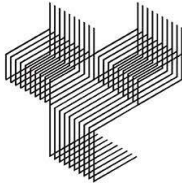
At IADE's Design course, Basic Design went by a few transformations along the years, namely, a segregation between 2D and 3D principles. Laboratório de Design 3D (Lab D3D) stands, therefore, on Basic Design's roots, presenting a teaching and learning methodology and class exercises developed by Fernandes (2011) (see Neves, Niemeyer, et al., 2016; Neves & Duarte, 2015; Neves, Duarte, & Dias, 2016, for more details).

Despite the differences between Lab D3D and Basic Design, a propaedeutic character links these two disciplines. As in Basic Design, in Lab D3D classes there are no real problems to be solved by the students, but an investment on a sensitivity for aesthetical-projectual phenomenon through the creation of abstract 3D structures. This practice returns in an overall attitude and personal adequate predisposition for addressing the complexity required for future learning in three main project areas: graphic, product and interior design. In this sense, Lab D3D continues Basic Design, considered an important pedagogical approach for developing visual intelligence in the present century (Findeli, 2001).

1.2 Virtual Reality

Virtual Reality (VR) is distinguished from other systems using Virtual Environments (VEs) and is characterized, according to the Triangle of RV proposed by Burdea and Coiffet (2003), by enhancing the interaction, immersion and imagination, resulting in different levels of presence. When compared with other systems using VEs, the VR systems allow the evaluation of more advanced aspects of interaction with the world, as behaviors or emotions with good ecological validity (Rebelo, Duarte, Noriega, & Soares, 2011). VR technology is currently used in a broad range of applications, such as games, movies, simulations, and a few main focus are training, education, collaborative work, therapy and learning (Lanyi, 2012). The technology allow the generation of phenomena, alternative experiences to reality, enabling some of today's most innovative pedagogical approaches (Schank, 2011), however, much of its potential is yet to unveil (Jones, 2013).

The potential of an immersive VR tool was assessed for creating architectural spaces, in a study by Angulo e Velasco (2014). They concluded that VR improved the performance and increased the critic and collaborative spirit between the students.



2 Methodology

To explore the impact of VR in the teaching-learning process (Neves, Niemeyer, et al., 2016), it was designed and implemented a case study in Lab D3D discipline in 2016 Spring semester¹. The main objective of the study was to explore the impact of two VR-based tools in the teaching-learning process, in Lab D3D classes.

The VR-based tools were developed to offer the opportunity to interact virtually with 3D structures. The first tool (VR-based tool 1) had the purpose to introduce the second exercise of the semester. The second tool (VR-based tool 2) intended to provide the students different scenarios where the 3D abstract structures created by them (manually, first, and digitally, right after) were imagined as objects with possible imagined affordances.

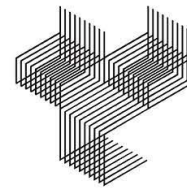
A quasi-experimental methodology allowed to compare two groups of students: control group - used the non-digital conventional methodology (verbal and 2D images); and experimental group - used a hybrid methodology (VR plus verbal and 2D). Participants were aged between 18 and 24 years old. Both groups presented homogeneous distributions of age and gender. A sample of only 10 students was used in each group.

The dependent variables were: self-perceived creativity level; self-perception of creativity barriers; self-perceptions of motivation and student's performance. Also the perceived emotional state of the students during the experience of use was assessed (made by video analysis) using a tool developed by Pieter Desmet (2003) for measuring physiological components of the emotional responses to products, the Product Emotion Measurement Instrument (PrEmo) (Desmet, 2003).

For VR-based 1, the procedure included the presentation of the briefing of the second exercise while using a VR-based tool. It was used to introduce the objectives, procedures and materials. Using a semi-immersive environment, the professor explained the exercise while the students interacted with the abstract structures from a 3D modular system, like the ones they were required to create manually. They moved the structures and also walked around them. The challenge could be understood at each one's own pace, according to their personal specific needs. Thus, the experience afforded an easy shifting between different structures, multiple perspectives and points of view, and also different materials, textures and light effects.

For VR-based tool 2, the exercise was introduced and, during the concept creation, a new VR-based tool is presented. Along one class, the students explored individually the structures developed until that moment, in different and changeable contexts of use. In this sense, the 3D objects were tested in different situations, preserving the richness and complexity that usually occur during real phenomenon interactions. More details about the methodology can be found at Neves, Niemeyer, et al., (2016), Neves and Duarte, (2015), Neves, Duarte, and Dias (2016).

¹ The methodological approach applied in the study with emphasis on the tools (e.g., questionnaires and virtual environments) was previously presented (see Neves, Niemeyer, et al., 2016; Neves, Duarte, et al., 2016).



3 Results

Results regarding the impact of the VR-based tools were based on the following measures: students' perceptions of creativity (within subjects and between subjects); motivation and barriers to creativity expression (within subjects and between subjects); and performance (between subjects). The analyses of the video recorded sessions indicated the quality of the experience of use, through emotions detection.

3.1 Statistical analysis

Although the reduced sample, an inferential statistical analysis was conducted to the referred variables. Data were analysed with SPSS v21 and an alpha level of .05 was used for all inferential analyses. Whenever the normality of the distribution was guaranteed ($p > .05$), parametric tests were used. However, since no significant differences were found in any of the measured variables, this results will not be reported here.

3.2 Video recorded analysis

To assess the quality of the students' experiences with the VR-based tools, video recordings of the sessions were analysed. During the use of both tools students showed behaviour that could be associated with specific emotions. Although face expressions are important for the analyses, they were not available because during the experiment, students were faced back to the camera. Only before and after the procedure is possible, in some cases, see the student's face expressions.

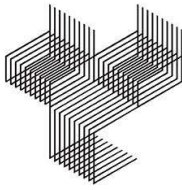
The immediate contact with the tool triggered some reactions in some students, such as arms movements trying to touch the structures; vocalizations (e.g., "Uuuu!", and "Uau!"); and laughs. During the session was registered the comments of students, such as: "funny"; "But this is very funny"; and "what a twist"². Another student expressed: "Top, look there!"³ when referring to the animation that reveals the way of assembling the pieces. Besides the comments, his body movement during the interaction revealed very enthusiasm (e.g., moving his head frequently following the structures; imitating the rotation at the animation C moving the arms and hands, and pointing the commands to the colleague, moving arms and hands toward the screen. Also in the free exploration phase, the same pair of students commented the structures resembling them with specific objects (e.g., boat casquet, tree). Another pair of students laugh out loud when a specific animation is activated. The same reaction was verified by others when exploring the successive rotations of the structure and the spinning effect.

Verbalizations at the end of the session were noticed, when a student mentioned to the colleague before leaving the room: "Very good!"⁴. Comments between students were

² Free translation from the original - "engraçado"; "mas isto é muito engraçado"; "que giro"; um outro estudante referiu: "esse tá bué fixe"; "tá fixe este efeito"

³ Free translation from the original - "top, olha lá!"

⁴ Free translation from the original - "muito bom!"



frequent, related to the exposed new concepts: *"Homeometry was the one we were seeing - yes"*⁵ or requests to change the position of the structure. Students change information about the proper commands to obtain a position. Specifically, one explains where is the command to rotate the structure, pointing to the screen and, in another group, another asks the partner to activate the homeometry. Also questions and doubts were posed to the teacher related to the presented exercise: *"But are we really going to build it?"* (nº 3); *"Which are the animated ones, teacher?"* (nº 4); *"This connection is not straight? ... that is, just do not just join it ... I realized, okay, I was trying to perceive"* (nº 10); *"Oh, they have to fit all!"*; *"Does it have to be all K-line work?" Does it have to be at least 10 pieces? Is that already counting on the connecting pieces? How this piece was made can also be done, right?"* (nº 7)⁶.

In pairs, students share ideas and overcome some doubts (nº 4). In a specific group where only one of them manipulated the structures (nº 4), while the other preferred to observe the colleague's moves (nº 5), was verified that the one that actively used the tool understood the procedure and could explained it to the colleague.

3.3 The flexible script

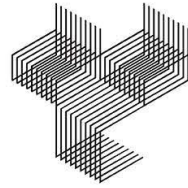
Although the teacher used a script to guide the 10 minutes presentation scheduled for each pair of students, few more minutes were required for free exploration. She felt important that all of the students understood the exercise, at their own pace. In that sense, the script was very useful, but revealed to be just a mere orientation. The teacher answered student's questions whenever asked and guaranteed the engagement during that time.

All students revealed to have understood the future exercise, although each group achieved that comprehension in a different manner. While some of them showed to be more autonomous and were very at ease during the interaction, others were less comfortable, but still, did everything without problems. All students showed some level of satisfaction during the session. We could say that from the group of ten, three revealed to have been pleasantly surprised in some moments, and the same number showed quite amused. Fascination was also revealed by three of them.

The second VR-based tool was used under different conditions, as already mentioned. From the analysed sample, only four of the students used a structure modelled by themselves, while the others used a specific one created for the purpose of this experience. The digital modelling of the structures was optional since it was not required in the curricular unit program. In this sense, most of the students didn't do the structure, despite the given tutorials. During both sessions, the teacher was at the classroom and

⁵ Free translation from the original - *"homeometria era aquela onde estavamos há bocado - sim"*

⁶ Free translation from the original - *"Mas vamos mesmo construir?"* (Nº 3); *"Quais são as que animam, professora?"* (Nº 4); *"esta ligação não é reta?...ou seja, basta não ser só o juntar...já percebi, ok, estava a tentar perceber"* (nº 10); *"Ah, têm que encaixar todas!"*; *"Tem que ser o trabalho todo em K-line?"*; *tem que ser no mínimo 10 peças? Isso já a contar com as peças de ligação? Como esta peça foi feita também podemos fazer, não é?"* (nº 7).



didn't oriented the experimental activities. Specially in the second day, students were completely involved in the curricular task at hands related with the final exercise, and despite the teacher highlighted the importance of the activity, they rushed during the virtual interaction and subsequently, under explored the tool. Sometimes, the researcher was giving suggestions for exploring missing commands.

Both groups (i.e., one per session) had different conditions while conducting the exercise. While the first group was introduced to the interface, the second one didn't. In this case, the researcher suggested the exploration of some commands according the student's reactions.

All of the students explored every different scenarios. They showed neutral face expressions and sometimes, a smiling face, revealing no unpleasant emotions. Instead, some rush to complete the task was noticed, specially, when looking for the time spent on the second day, that was considerably lower (i.e., average of 8.17, in the first day, and 3.5 minutes, in the second day). In the first session students used the time to take notes about their impressions. They carefully explored different possibilities and showed some interest and engagement in the activity, while the other group evidenced lack of interest in the activity.

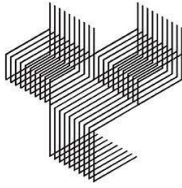
There is one student that reacted vocally, when activated the panel: "ah!". Another said, in the interior camera: "*Oh how funny*" and also "*oh how strange*"⁷, revealing a pleasant surprise. To some students, the abstract structures presented many differences from the ones they were working manually, at that moment. From a premature phase, during the third exercise, the students changed the structures according their preferences and most of them didn't resembled the initial ones.

4 Conclusions

In order to explore the contributions of VR for learning Basic Design topics, Lab D3D curricular unit was selected as a case study. The pilot study described in this paper allowed testing the developed procedures and tools in an actual pedagogical context. It also allowed the acknowledgment of the complexity of such task and provided possible directions for future work. Some major difficulties were noticed on the integration of the research activities in the programmatic activities:

- **Planning:** because many students were late with the assignments, their availability to participate in the experiment was diminished due to the deadline approach and, therefore, only few answered the last questionnaire after completing the last exercise of the semester. They were asked to answer the questionnaire in the following semester, i.e., 2016-17, which affected the results.

⁷ Free translation from the original - "ai que engraçado" e também: "ai que estranho".



An adequate timing is important, e.g., contemplative, instead of high time pressure moments.

- **Low proficiency with 3D modelling software:** despite the given tutorials, the students revealed important difficulties to model digitally their structures. To overcome this difficulty, we provided them a pre-modelled structure and they were discharged from the 3D modelling activity. In future studies, students should be previously trained on using 3D software.
- **Limitations of the VR system:** the used VR system presented limited interaction abilities; e.g., the device used for interacting with the VE was a keyboard and a mouse. Despite the “wow” moment visible in the first interactions with the VR tool, it was evident that the devices restricted students’ natural movements, affecting their performance, motivation and creativity, including the sense of presence and engagement, specially, when considering the importance of the proprioception in the learning process. In future studies, other devices; e.g., Leap Motion or VR gloves, should be tested.
- **Technical assistance:** The system required constant technical support, demanding both competencies on computer graphics and computer sciences. Because the amount and timing of the technological occurrences are difficult to foresee, which can jeopardize a whole class day for the students, a careful planning is required to allow a regular assistance by the VR engineer/technician.
- **Methodological limitations:** a double-blind evaluation of the results gathered from the students was not possible because only one class/professor was involved in the pilot study. Thus, the regular score given by the class professor, that proceeded as usually, was used to assess the students’ performance on Lab D3D. Other measures of performance should be used in future studies.
- **Duration of the VR experience:** Because of the nature of the planned exercises and the features of the VR system, the experience with the VR was relatively short (i.e., a few ten minutes for a pair of students, in the VR-based tool 1; and ten minutes for each one during the use of the VR-based tool 2). Thus, an effect of the reduced time available during the interaction on the results gathered is very likely.

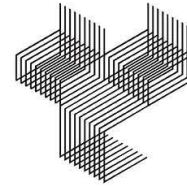
Considering the difficulties listed above, as well as the nature and characteristics of the Lab 3D discipline, a decision was made to not continue with the study in this Curricular Unit, making it necessary the selection of another case study for continuing the research.

Acknowledgments

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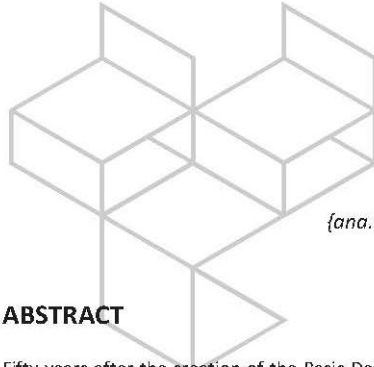
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References

- Aneschi, G. (2010). Design di base: fundamenta del design. *Il Verri 'Newbasic'*, (43). Retrieved from <http://www.ilverri.it/index.php/la-rivista-del-verri/edizione-dal-1996/newbasic-detail>
- Angulo, A., & Velasco, G. V. de. (2014). Immersive Simulation of Architectural Spatial Experiences (pp. 495–499). Editora Edgard Blücher. <https://doi.org/10.5151/despro-sigradi2013-0095>
- Boucharenc, C. G. (2006). Research on Basic Design Education: An International Survey. *International Journal of Technology and Design Education*, 16(1), 1–30. <https://doi.org/10.1007/s10798-005-2110-8>
- Burdea, G. C., & Coiffet, P. (2003). *Virtual Reality Technology* (2 edition). Hoboken, N.J: Wiley-IEEE Press.
- Cetinkaya, C. (2014). Basic Design Education Parameters in Turkey. In *Humanitas International Journal of Social Sciences* (pp. 31–46). Central and Eastern European Online Library.
- Desmet, P. (2003). Measuring Emotion: Development and Application of an Instrument to Measure Emotional Responses to Products. In M. A. Blythe, K. Overbeeke, A. F. Monk, & P. C. Wright (Eds.), *Funology* (pp. 111–123). Springer Netherlands. https://doi.org/10.1007/1-4020-2967-5_12
- Fernandes, R. (2011). *Design, Informação e Desenvolvimento: um contributo metodológico para a exploração do 'Potencial Informativo do Produto' como fator de percursos de rápida 'mudança emergente' orientada para o desenvolvimento*. Universidade Complutense de Madrid, Madrid.
- Findeli, A. (2001). Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion. *Design Issues*, 17(1), 5–17. <https://doi.org/10.1162/07479360152103796>
- Jones, D. (2013). An Alternative (to) Reality. In M. Childs & A. Peachey (Eds.), *Understanding Learning in Virtual Worlds* (pp. 1–20). New York: Springer.
- Lanyi, C. (Ed.). (2012). *Applications of Virtual Reality*. InTech.
- Neves, A. G., & Duarte, E. (2015). Using Virtual Environments in Basic Design Education. In E. Duarte, C. Duarte, & F. Carvalho Rodrigues (Eds.), *Senses & Sensibility'15: Design as a Trade Proceedings of the UNIDCOM/IADE 8th International Conference* (pp. 273–280). Lisboa, Portugal: IADE - Creative University / Edições IADE.
- Neves, A. G., Duarte, E., & Dias, D. (2016). Basic Design meets Virtual Reality: A tentative methodology. In *Design Doctoral Conference Proceedings*. IADE-U Lisboa.
- Neves, A. G., Niemeyer, L., Duarte, E., Dias, D., Ayanoğlu, H., Teixeira, L., ... Martins, F. (2016). Learning Basic Design with Virtual Reality: A methodological approach. In *EDULEARN16 Proceedings*. Barcelona.
- Rebelo, F., Duarte, E., Noriega, P., & Soares, M. M. (2011). Virtual Reality in Consumer Product Design: Methods and Applications. In Waldemar Karwowski, Marcelo M. Soares, & Neville A. Stanton (Eds.), *Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques* (pp. 381–402). CRC Press.
- Schank, R. C. (2011). *Teaching Minds: How Cognitive Science Can Save Our Schools*. Teachers College Press.

Basic Design at IADE: Drawing the line



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ABSTRACT

Fifty years after the creation of the Basic Design Course at Bauhaus School of Design, the *Instituto de Arte e Decoração – IADE* pioneered design education in Portugal during the year of 1969. As in a great number of schools all over the world and despite the changes occurred since its generation, Basic Design presence is still noticed at IADE's current design courses. This institute now welcomes a study that addresses the impact of Virtual Reality on the pedagogical experiences related with basic Design of the freshman design students. In this context, and as part of the above-mentioned research, this paper intends to highlight the presence and evolution of Basic Design at IADE. Such diachronic analysis consists of a first glance into the subject, for which an agenda will be advanced to present aspects that range from IADE's cultural and philosophical influences to the adopted pedagogical options. Therefore, the present study aims to contribute to learning design, informing details about the specific context.

Keywords: Design education, Basic Design, IADE, Portugal.

INTRODUCTION

Since Bauhaus Design School (1919-1933) design education firmed its presence in the world. The *preliminary*, later called basic course, was considered one of this school's main pillars (Bonsiepe, 2012) and, as presumed by Cross (1983), Bauhaus' most important educational innovation. Basic Design was created by Johannes Itten (1888-1967) as a six-month course with the purpose to free and strengthen imagination and creativity of the freshman design students (Itten, 1975). The focus on creativity and on the development of personal abilities was achieved by exploring the theory and practice of polar contrasts, as well as by performing relaxation and concentration exercises. These were part of a methodology for training intuition and the cultivation of self-knowledge, since an "outward looking scientific research and technology must be balanced by inward looking thinking and by spiritual forces" (Itten, 1975, p. 9). The influence of Dewey's school of thought, but also, Floerbel and Montessori, in the pedagogical experiences lead by Itten, corresponds to a factor of innovation at high education teaching level (Cross, 1983).

László Moholy-Nagy (1895-1946) developed one of the subsequent Basic Design models, at the New Bauhaus of Chicago, in 1937. This design course program kept Bauhaus general structure, essential for promoting the designer as an integrator (Moholy-Nagy, 1947). The *preliminary* aimed the ability to express the design elements (i.e., line, shape, color, space, movement, texture, volume) in various media, starting with tangible two-dimensional and three-dimensional (e.g., pen, pencil, paper, clay, wood); and then, intangible (e.g., light, space and sound). These explorations promoted visual intelligence, allowing to understand and transform the invisible relations between system's elements, in all its complexity (Findeli, 2001, p. 14).

At Ulm School (1953-1968), science and technology were reinforced in the general model of the design course, giving less space for artistic explorations. Subjective ways of creating forms were replaced for processes to develop formal synthesis using formal coherence.

In Italy, the influence of the Ulm director, Tomás Maldonado (1922), was predominant over Marcolli's theoretic proposal (1971). The projectual pedagogy, named *Teoria del Campo* (Marcolli, 1971, 1978) revealed an unfamiliar language and a high level of abstraction, largely contributing to the few references found, including, at the Italian design education scenario, (Federle, 2009, p. 22). *Teoria del Campo* consists of a propedeutic course for developing the visual perception through four successive fields/spaces: geometric-intuitive; gestalt; topological; and phenomenological. Each field is addressed according to: its structure; the composition of objects; object-field interaction; and finally, tension and movement. The implementation of such a perceptive system is provided by the operationalization of the transformational geometry: Euclidean; affine and projective; topological; and set theory.

The intensity and consistency of the abstract exploratory exercises, more geometric-based in the case of Marcolli (1930-2010) was considered absolutely essential for design learning, in the perspective of both Marcolli and Munari's point of view (Marcolli, 1971; Munari, 1998). According to Munari (1907-1998), for an effective learning is important to deepen all the topics despite that they may seem not relevant to the enthusiastic young people, who would prefer to draw projects immediately or play instruments (Marcolli, 1971; Munari, 1998).

Almost celebrating one century of existence, Basic Design is internationally implemented and adapted to the present times (Cetinkaya, 2014). In general, Basic Design corresponds to a specific pedagogical approach that addresses the way design fundamentals or the Principles of Two-and Three-dimensional Design are taught and learned. By adopting a holistic, creative and experimental methodology, it focuses elements of shape, color, texture, light, and rhythm integrated in aesthetic and formal exercises.

Some debates in the beginning of the century promoted a rebirth of Basic Design education, which can also be confirmed by the present use of pedagogical approaches similar to those developed in the past by some of the great design schools, as identified at an international study by Boucharenc (2006, p. 14). Some innovative Basic Design approaches are being conducted at IADE, where a research intends the development of a Virtual Reality-based pedagogical tool. Neves and Duarte (2015, 2016) and Neves et al. (2016) already have undergone some steps in that direction, for which a VR-based tool was tested in the context of a Basic Design rooted course (CU), "Laboratório de Design 3D", at IADE. While addressing Basic Design main roots at IADE, this study deepens and reinforces the stated perception that Basic Design persists in the present design course (Neves et al., 2016).

This diachronic analysis was based on official documents available at IADE's academic services and library (e.g., statutes, regulations, course programs, proposals for the constitution of the discipline, and curricular unit files).

PORTUGUESE DESIGN EDUCATION

The first design pedagogical experiences in Portugal took place during the last sixties, despite the word "Design" being officialised only in 1971, at the *I Exposição de Design Portugues* (Silva, 2001). The *Escola de Artes Decorativas António Arroio – EADAA*, largely contributed, during the forties and fifties, to the transformation of the Portuguese artistic teaching (Souto, 2009) and, consequently, to the design pedagogy. Lino António (1898-1974), Frederico George (1915-1994) and Daciano da Costa (1930-2015) featured the process, next to other teachers at EADAA, overcoming the academic teaching based in the *Beaux-Arts* tradition. In this sense, aspects of the *Arts and Crafts* movement filtered by the Bauhausian legacy were introduced in the Portuguese educational system (Almeida, 2009; Souto, 2009).

Two pedagogical experiences marked the genesis of formal¹ design education in Portugal: starting in 1965, the *Curso de Formação Artística*, at Sociedade Nacional de Belas Artes - S.N.B.A.; and at 1969, the *Curso de Decoração de Interiores*, at Instituto de Arte e Decoração - IADE (Almeida, 2009; Souto, 2009).

Other type of learning experiences in design were the ones promoted by the *Instituto Nacional de Investi-*

¹ Underlined by Victor de Almeida at *O Design em Portugal, um Tempo e um Modo. A institucionalização do Design Português entre 1959 e 1974* (doctoral thesis), 2009, the educational dimension in the Portuguese Design, can be organized according a model that establishes three educational categories: informal learning; non-formal learning; and formal education. Accordingly, informality marked the education mainly oriented at the workshops of the masters and in the context of the projectual activities. Non-formal design education implied an organized and systematized educational activity developed out of the formal educational system, such as free courses for professional specialization, workshop classes, seminars and formation sessions. Finally, formal design education requires the attendance of design courses in educational institutions and involves certification by the public organs and social recognition.

gação Industrial – INII, a national institute created for the development and modernization of the Portuguese industry. INII aimed the inclusion of design through some of the following actions of *Núcleo de Arte e Arquitectura Industrial*: short professional courses in the scope of design; *I Quinzena de Estética Industrial*; and simultaneously the *Exposição Internacional de Design Industrial*. These experiences exemplify the non-formal learning mode, known for promoting a self-learning process, which coexisted and complemented the dominant informal design learning.

The design courses created, first in a private context, by *Instituto de Arte e Decoração - IADE*, at 1969, and subsequently in the public *Escola Superior de Belas-Artes de Lisboa - ESBAL*, in 1974, were certified by the Ministry of Education during the seventies and eighties, respectively. The official recognition of the *Curso de Design de Interiores e Equipamento Geral* from IADE, *Escola Internacional de Decoradores, Artistas Gráficos e Designers* happened in 1979² and for the ESBAL courses in 1983 (Almeida, 2009). It was the start of formal design education.

Basic Design

The first reference in the Portuguese context to Basic Design points to the pedagogical experience created by the designer and, at the time, teacher at EADAA, Daciano da Costa. Between 1962 and 1964 he undertook, in his own workshop, a private teaching course (Costa, 2001). In the scope of Basic Design, the design problems were analysed according a bauhausian structure: the approach of the genesis of the form was based on an experimental didactics informed by Itten's theories of colour and form and also influenced by Laszlo Moholy-Nagy and Josef Albers (Souto, 2001).

Pioneering Design Education: The case of IADE

1969 marks the foundation of Instituto de Arte e Decoração – IADE, frequently considered the pioneer institution for teaching design in Portugal. According to Almeida (2009), the spread idea relates the large contribution of IADE in opening the debate around the discipline, provided by courses and seminars in the beginning of its existence, developed out of the workshops and corporations environments. António Quadros (1923-1993), philosopher, writer, teacher and director of IADE between 1973 and 1993, was the founder of the institute. IADE's first director was the painter Lima de Freitas (1927-1998).

The three-years *Curso de Decoração de Interiores* (Interior Decoration program) opened in the same year, with the curricular program as presented at "Figure 1".

VISTA COTAR

MATERIALS - des. material - des. ref. - 12.0		SPONSORES - des. soc. - des. ref. - 12.1		CATEGORIAS		INSTRUMENTOS		VALORES	
QUANT.	VALOR	QUANT.	VALOR	QUANT.	VALOR	QUANT.	VALOR	QUANT.	VALOR
1	2.00	1	2.00	1	2.00	1	2.00	1	2.00
2	2.00	2	2.00	2	2.00	2	2.00	2	2.00
3	2.00	3	2.00	3	2.00	3	2.00	3	2.00
4	2.00	4	2.00	4	2.00	4	2.00	4	2.00
5	2.00	5	2.00	5	2.00	5	2.00	5	2.00
6	2.00	6	2.00	6	2.00	6	2.00	6	2.00
7	2.00	7	2.00	7	2.00	7	2.00	7	2.00
8	2.00	8	2.00	8	2.00	8	2.00	8	2.00
9	2.00	9	2.00	9	2.00	9	2.00	9	2.00
10	2.00	10	2.00	10	2.00	10	2.00	10	2.00
11	2.00	11	2.00	11	2.00	11	2.00	11	2.00
12	2.00	12	2.00	12	2.00	12	2.00	12	2.00
13	2.00	13	2.00	13	2.00	13	2.00	13	2.00
14	2.00	14	2.00	14	2.00	14	2.00	14	2.00
15	2.00	15	2.00	15	2.00	15	2.00	15	2.00
16	2.00	16	2.00	16	2.00	16	2.00	16	2.00
17	2.00	17	2.00	17	2.00	17	2.00	17	2.00
18	2.00	18	2.00	18	2.00	18	2.00	18	2.00
19	2.00	19	2.00	19	2.00	19	2.00	19	2.00
20	2.00	20	2.00	20	2.00	20	2.00	20	2.00
21	2.00	21	2.00	21	2.00	21	2.00	21	2.00
22	2.00	22	2.00	22	2.00	22	2.00	22	2.00
23	2.00	23	2.00	23	2.00	23	2.00	23	2.00
24	2.00	24	2.00	24	2.00	24	2.00	24	2.00
25	2.00	25	2.00	25	2.00	25	2.00	25	2.00
26	2.00	26	2.00	26	2.00	26	2.00	26	2.00
27	2.00	27	2.00	27	2.00	27	2.00	27	2.00
28	2.00	28	2.00	28	2.00	28	2.00	28	2.00
29	2.00	29	2.00	29	2.00	29	2.00	29	2.00
30	2.00	30	2.00	30	2.00	30	2.00	30	2.00
31	2.00	31	2.00	31	2.00	31	2.00	31	2.00
32	2.00	32	2.00	32	2.00	32	2.00	32	2.00
33	2.00	33	2.00	33	2.00	33	2.00	33	2.00
34	2.00	34	2.00	34	2.00	34	2.00	34	2.00
35	2.00	35	2.00	35	2.00	35	2.00	35	2.00
36	2.00	36	2.00	36	2.00	36	2.00	36	2.00
37	2.00	37	2.00	37	2.00	37	2.00	37	2.00
38	2.00	38	2.00	38	2.00	38	2.00	38	2.00
39	2.00	39	2.00	39	2.00	39	2.00	39	2.00
40	2.00	40	2.00	40	2.00	40	2.00	40	2.00



ESCOLA INTERNACIONAL DE DECORADGES

CLUB NO. 204

WING DECORADGES

DATA DE CRIACAO 23.08.10

Nome: _____

Matrícula do Aluno: _____ Data de Nascimento: _____

Nome dos Pais: _____

Endereço da Alameda: _____

Endereço da Escola e Instrutoria: _____

Curso de ensino (do primeiro _____)

Inscrição da Escola (do primeiro _____) Curso: _____

Matrícula da Escola (do primeiro _____) Instrutor: 06.11.01

Figure 1 - Curricular program of the course in the first academic year of 1969-1970

The program aimed the teaching of art and decorative courses within the general intention of supporting the study and dissemination of the arts and sciences (Diário do Governo: III série, Nº 235 (1969), 1969). IADE had painters as teachers such as: Manuel Lapa, Lima de Freitas, Rafael Calado, Eduardo Nery and Manuel Costa Cabral. The architects Francisco Keil do Amaral, Manuel Costa Martins and Júlio Gil, the sculptor Graça Costa Cabral, the designer John David Bear, and also António Quadros were teachers at the institute (IADE – Instituto de Artes Visuais, Design e Marketing, 1989).

In 1970, the arrival of John Bear, graduated at the Royal College of Arts, promoted changes at the pedagogical orientations at the institute, where "the primitive concept of decoration was replaced by "design", much broader, updated and undoubtedly, more appropriate to the future of the Portuguese industry and

²Resolução n.º 171/79 da Presidência do Conselho de Ministros – Gabinete do Primeiro-Ministro. Diário da República 127/1979, Série I de 1979-06-02, n.d.

economy”³ (IADE – Instituto de Artes Visuais, Design e Marketing, 1989, p. 17). The integration of the new concept was also due the influence of the French designer, Claude Ternat (from the *Centre de Recherches d’Esthétique Industrielle - CREE*), and the connections with the *Scuola Politecnica di Design*, from Milan, Italy. The close cooperation with the director, Di Salvatori, allowed IADE the organization of seminars about design since the academic year 1973-74. Bruno Munari and Marcolli oriented seminars at IADE in the seventies and eighties, largely contributing to the pedagogical options at the institute. During 1977, Bruno Munari worked with the school teachers analyzing IADE’s program, “resulting in flagrant improvements in the curriculum, its content and methods.”⁴ (IADE – Instituto de Artes Visuais, Design e Marketing, 1989, p. 18).

Basic Design at IADE

The first IADE’s curricular programme mentioning Basic Design, available for this study, dates from the academic year 1979-80, from *Curso de Design de Interiores e de Equipamento Geral*, as presented at “Figure 2”.

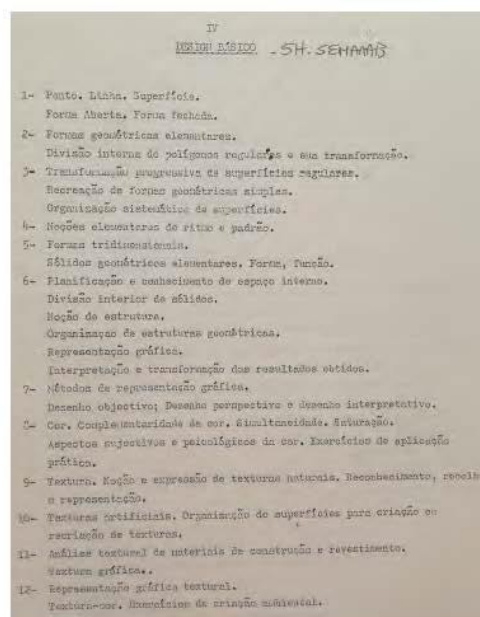


Figure 2 - 1979 Basic Design programme

The course curriculum during the eighties (IADE - Escola Internacional de Decoradores, Artistas Gráficos e Designers, (s.d.)) for the first year, establishes a set of Curricular Units that include *Design Básica*, next to: *Introdução ao Design*; *Problemas da Estética Industrial*; *Psicologia da Comunicação Visual*; *Estética e História de Arte I*; *Desenho*; and *Desenho Técnico*. The 1982 Basic Design Curricular Unit File (IADE - Escola Internacional de Decoradores, Artistas Gráficos e Designers, 1982), integrally repeats the previous. However, much more details relating the course, such as the pedagogic options, are revealed. Accordingly, the three successive years are devoted to the basic equipment; professional initiation; and professional formation of the students, respectively. All the subjects intend to fulfil the interrelated set of organic needs: education of the spirit; cultural formation; scientific and technological information; and practical experimentation.

³Translated by the authors.

⁴Translated by the authors.

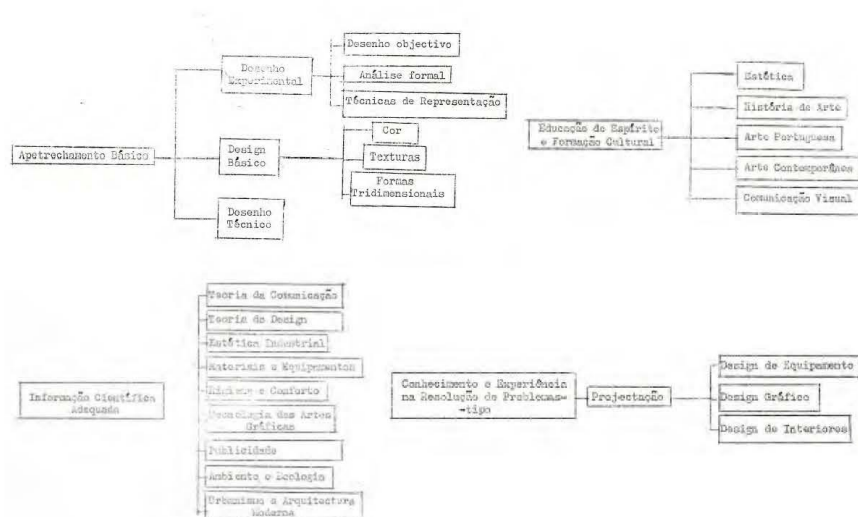


Figure 3 - Organic table of subjects for *curso de Design de Interiores e de Equipamento Geral*, 1982

In 1986, the topics previously addressed at *Design Básico: Iniciação ao Estudo da Cor e da Textura*; *Desenho de Letra*; and *Desenho Experimental I*, became independent Curricular Units (IADE - Escola Internacional de Decoradores, Artistas Gráficos e Designers, 1986) and Basic Design disappeared from the course programme. The same document (1986) mentions that the recently created three-year *curso de Design de Moda*, at 1984, adopted some Curricular Units from the ongoing *curso de Design de Interiores e de Equipamento Geral*, such as *Design Básico* (Basic Design), *Desenho Técnico*, *História da Arte* and *História do Design*.

Basic Design was again integrated in the course programme during the academic year of 1988/89, as shown in "Table 4". The following academic year of 1989/90, Basic Design is shown as a recombination of the three independent Curricular Units.

1º ANO - 88/89			
DESIGN BÁSICO	3 x	2,5 + 2,5 + 2,5	
DESENHO TÉCNICO	2 x	2,5 + 2,5	
GEOMETRIA DESCRITIVA	1 x	2,5	
DESENHO DE LETRA	1 x	2	
HISTÓRIA DA ARTE	2 x	1 + 1	
HISTÓRIA TEÓRICA / DESIGN	1 x	1	
PSICOLOGIA	1 x	1	
TOTAL		21 HORAS	

1º ANO - 89/90			
DESIGN BÁSICO	3 x	2,5 + 2,5 + 2,5	
(COR / DESENHO EXPERIMENTAL / LETRA)			
DESENHO TÉCNICO	2 x	2,5 + 2,5	
GEOMETRIA DESCRITIVA	2 x	2,5 (1+1,5)	

Figure 4 - Basic Design first year programme during the academic years of 1988/89 (left) and 1989/90 (right)

In 1989, IADE is renamed Instituto de Artes Visuais, Design e Marketing, S.A. (Diário da República 68/1989, 1º Suplemento, Série III, 1989). The institute affirmed its orientation to "the promotion and teaching of the arts, sciences and techniques, particularly, through audio-visual courses, interior design and general equipment, fashion design and marketing and advertising"⁵ (Diário da República 68/1989, 1º Suplemento, Série III, 1989, pp. 5296-(28)).

During the following year, both *curso superior de Design* and *curso superior de Marketing e Publicidade* were officially recognized as bachelor degree (Portaria n.º 672/90 do Ministério da Educação. Diário da República 187/1990, Série I de 1990-08-14, n.d.). At the time, the Design course offered specialization in three fields: Visual Design; Industrial Design; and Interior Design. The two first years, of a three-years plan, were common to all fields. The specific curricular units from each field were lectured during the last year. The only difference between 1989 and 1990 Basic Design Curricular Unit Files is the reference to the methods, in the

⁵ Translated by the authors

- In 1990, the 12 topics initial structure of Basic Design Curricular Unit File, as shown in “Figure 2” adopted the present model (i.e., that includes contents; objectives; and methodology).
- In 1989 Basic Design Curricular Unit File (IADE - Escola Internacional de Decoradores, Artistas Gráficos e Designers, 1989) creativity appears for the first time, maintaining and reinforcing its presence along the subsequent years. Namely, the document includes “creative proposals”⁶ at an introductory text that mentions the student’s objectives and “creative explorations”⁷ as a fundamental vector.
- Breathing and relaxation exercises is not noticed in any version of Basic Design Curricular Unit.
- The present Curricular Units, *Laboratório de Design 3D* and *Laboratório de Design 2D*, evolved in abstract and exploratory approaches to form creation, and in projectual exercises that also include typographic content, respectively.
- The topic “textures”, represented in the Basic Design content until 2002-03, was abandoned and presently is not found at any of those Basic Design-based Curricular Units.

Final remarks

Besides the identification of Basic Design at IADE, allowed by this study, it is important to reinforce the gap of data relating the first ten-year period of IADE’s existence. For that reason more research is needed to reveal more aspects of IADE’s pedagogy from the mentioned period, for which the use of other methods should also be applied to collect data, such as interviewing students and teachers.

At the several documents analyzed for this study underlies the idea that IADE’s pedagogic options may have been influenced not just by the classic design schools, or its main authors’ ideas, but by some trends of the national philosophical and cultural thought. In general, the study of the impact of XX century Portuguese main figures in IADE’s pedagogy is yet to be done. António Quadros and Lima de Freitas, who shared humanistic values and spiritual convictions, and particularly, the last one, who dedicated “Voz Visível” to his IADE students compares, at the chapter *Ponto de Fuga*, (Freitas, 1971), the work of a painter as a transformative path. The discourse is rich in analogies between the world of the image and hinduism, where the painting is also considered the alquimic of light. This may suggest some permeability of the artist’s work to his religious and spiritual beliefs. In fact, similar connection were revealed by Johannes Itten, at *Design and Form* (1975). Due this fact, and despite the 50 years of difference between Bauhaus and IADE, the common aspects relating these two episodes, featured by Johannes Itten and Lima de Freitas, both painters and charismatic teachers in the starting point of German and Portuguese design pedagogic experiences, deserves some attention.

Also, a closer analysis to the Curricular Unit Files, which were available for the study, is recommended for tracing a more detailed picture of the evolution of the topics: objectives; contents; methods; and bibliography. It will also allow clarifying the influence of the Basic Design main authors, as well as the classic schools on IADE’s Basic Design approach. As this diachronic analysis reveals the presence of Basic Design at IADE, is suggested that Basic Design may persist at the present Portuguese design courses, for which a synchronic analysis is immediately recommended.

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REFERENCES

- Almeida, V. (2009). *O Design em Portugal, um Tempo e um Modo. A institucionalização do Design Português entre 1959 e 1974* (doutoramento). Faculdade de Belas Artes, Universidade de Lisboa, Lisboa. Retrieved from http://repositorio.ul.pt/bitstream/10451/2485/2/ulsd059655_td_Tese_Victor_Almeida.pdf
- Bonsiepe, G. (2012). *Design como Prática de Projeto*. Brasil, S. Paulo: Edgard Blucher.
- Boucharenc, C. G. (2006). Research on Basic Design Education: An International Survey. *International Journal of Technology and Design Education*, 16(1), 1–30. <https://doi.org/10.1007/s10798-005-2110-8>

⁶ Translated by the authors

⁷ Translated by the authors

- Cetinkaya, C. (2014). Basic Design Education Parameters in Turkey. In *Humanitas International Journal of Social Sciences* (pp. 31–46). Central and Eastern European Online Library.
- Colucci, K. (2011). What role will technology play in the future of design education. In *Icograda Design Education Manifesto 2011* (pp. 63–67). Retrieved from http://toolkit.icograda.org/database/rte/files/PR_IEN_Manifesto2011_webres.pdf
- Costa, D. da. (2001). Curriculum Vitae.
- Cross, A. (1983). The educational background to the Bauhaus. *Design Studies*, 4(1), 43–52. [https://doi.org/10.1016/0142-694X\(83\)90007-8](https://doi.org/10.1016/0142-694X(83)90007-8)
- Despacho n.º 2102/2018. Diário da República n.º 41/2018, Série II de 2018-02-27 (2018). Retrieved from www.dre.pt
- Despacho n.º 9094/2010. Diário da República n.º 102/2010, Série II de 2010-05-26. Retrieved from www.dre.pt
- Diário da República 68/1989, 1.º Suplemento, Série III (1989). Retrieved from www.dre.pt
- Diário do Governo: III série, N.º 235 (1969) (1969). Retrieved from www.dre.pt
- Federle, G. (2009). *Basic Design La formazione al design nella Scuola secondaria* (Doutoramento). Università Ca' Foscari Venezia, Venezia, Italia. Retrieved from http://dspace.unive.it/bitstream/handle/10579/1016/Tesi_Federle_2010.pdf?sequence=1
- Findeli, A. (2001). Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion. *Design Issues*, 17(1), 5–17. <https://doi.org/10.1162/07479360152103796>
- Freitas, L. de. (1971). *Voz Visível*. Lisboa: Ed. Autor.
- IADE. (1999, 2000). Programa do Curso Superior de Design. Licenciatura 1999/2000. (documento interno).
- IADE. (2014). Disciplinas do Plano de Estudos da Licenciatura em Design, 2014/15. (documento interno).
- IADE - Escola Internacional de Decoradores, Artistas Gráficos e Designers. ([s.d.]). Regulamento da Escola Internacional de Decoradores, Artistas Gráficos e Designers. Escola Livre de Artes Visuais. Centros de estudos, investigação e documentação. Planos de Estudos, Currículos e regulamentos internos do IADE dos anos 80 (nota). (documento interno).
- IADE - Escola Internacional de Decoradores, Artistas Gráficos e Designers. (1982). Conceito e objetivos; curriculum; e programas do Curso de Design de Interiores e de Equipamento Geral. (documento interno).
- IADE - Escola Internacional de Decoradores, Artistas Gráficos e Designers. (1986). Conceito e objetivos; curriculum; e programas do Curso de Design de Interiores e de Equipamento Geral. (documento interno).
- IADE - Escola Internacional de Decoradores, Artistas Gráficos e Designers. (1989). Programas do Curso de Design de Interiores e de Equipamento Geral dos anos letivos 1988/89 e 1989/90. (documento interno).
- IADE – Instituto de Artes Visuais, Design e Marketing. (1989). Requerimento para autorização de criação e funcionamento da Escola Superior de Design e da Escola Superior de Marketing e Publicidade. (documento interno).
- Itten, J. (1975). *Design and Form: Basic Course at the Bauhaus* (Revised edition edition). London, England; New York: Titles Supplied by John Wiley & Sons Australia.
- Marcolli, A. (1971). *Teoria del Campo - corso di educazione alla visione* (1998th, 17ª ed ed.). Milano: Sansoni Editore.
- Marcolli, A. (1978). *Teoria del Campo 2 - corso di metodologia dalla visione* (1991st, 3ª ed. ed.). Itália, Firenze: Sansoni Editore.
- Moholy-Nagy, L. (1947). *Vision in Motion*. United States of America: Wisconsin Cuneo Press.
- Munari, B. (1998). *Design e Comunicação Visual* (1 edition). São Paulo: Martins Fontes.
- Neves, A. G., & Duarte, E. (2015). Using Virtual Environments in Basic Design Education. In E. Duarte, C. Duarte, & F. Carvalho Rodrigues (Eds.), *Senses & Sensibility'15: Design as a Trade Proceedings of the UNIDCOM/IADE 8th International Conference* (pp. 273–280). Lisboa, Portugal: IADE - Creative University / Edições IADE.
- Neves, A. G., & Duarte, E. (2016). Using Virtual Environments in Basic Design Education. *The Radical Designer*, (Senses & Sensibility'15 ThRAD Special Issue). Retrieved from http://www.iade.pt/unidcom/radicaldesignist/wp-content/uploads/2016/02/ThRad-SS15__ANeves-EDuarte.pdf
- Neves, A. G., Niemeyer, L., Duarte, E., Dias, D., Ayanoğlu, H., Teixeira, L., ... Martins, F. (2016). Learning Basic Design with Virtual Reality: A methodological approach. In *EDULEARN16 Proceedings*. Barcelona.
- Portaria n.º 61/2003 do Ministério da Ciência e do Ensino Superior. Diário da República 13/2003, Série I-B de 2003-01-16. Retrieved from www.dre.pt
- Portaria n.º 672/90 do Ministério da Educação. Diário da República 187/1990, Série I de 1990-08-14. Retrieved from www.dre.pt
- Portaria n.º 866/93 do Ministério da Educação. Diário da República 216/1993, Série I-B de 1993-09-14. Retrieved from www.dre.pt
- Silva, A. S. da. (2001). Modos de aprender. In *Daciano da Costa Designer* (Fundação Calouste Gulbenkian, pp. 12–17). Lisboa.
- Souto, M. H. (2001). Daciano da Costa e o ensino do Design em Portugal. In *Daciano da Costa Designer* (Fundação Calouste Gulbenkian, pp. 34–41). Lisboa.
- Souto, M. H. (2009). *História do Design em Portugal I* (Edições IADE). Lisboa, Portugal.

AS BASIC DESIGN PROMOTES THE DESIGN LEARNING: FEATURING THE PORTUGUESE HIGHER EDUCATION SETTING

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Abstract

The present study addresses the conceptual mapping of Design Education, in general, focusing the conceptualization of Basic Design in the present scenario of High Education, in Portugal. A list of learning outcomes shall result from this mapping, which will be subsequently used for the developing of a Virtual Reality-based tool for teaching Basic Design. Framed in/aligned with a tradition that matches the very genesis of design, the Basic Design persists and affirms itself internationally as an inescapable construct in the training of young designers. Its basic character in and for learning Design is justified by the fact that the Basic Design derives from a holistic philosophy that promotes personal skills and the development of creativity and intuition, among others, embodied in an initiative dating from 1919 that established a semester course known as Bauhaus Basic Design Course. The increasing interest in Basic Design, seen in the last years, reviews it as an introductory discipline to the Design principles, targeting the freshman students at the higher education in this scientific domain. In fact, some characteristics persist that allow us to perceive the proximity of the Basic Design being practiced today, with that initiated by Johannes Itten, the most prominent figure of this episode. In this sense, based on the main literature related to the Basic Design, we propose an aggregator set of characteristics that unveil the presence of teaching-learning paths that appeal to this nature. Therefore, the curricular plans of the Portuguese High Education Design courses, which were available for this study, were analysed and, according to a previously established matrix, the Curricular Units were selected as configurators of the Basic Design principles. The selection was made according to the presence of some of the following settings, in several degrees of combination: the workload/ECTS; the experimental methodologies, with a strong practical component intending the promotion of creativity and requiring the valorization of free exploration, using different materials and techniques; the programmatic contents, by including the principles of 2D and 3D design, such as symmetry, formal coherence, modularity and standardization, and others attributed to the visual arts, such as harmony, balance, including the Gestalt laws; and, finally, learning objectives such as the design of objects according to more aesthetic than technical parameters, more personal than specific from the discipline. The first results suggest that the current Design teaching and learning is being reviewed in the principles initially formulated intending to introduce the students to the Design discipline, making it available simultaneously to its own reinvention.

Keywords: Basic Design, Design Education, Portuguese High Education, Virtual Reality.

1 INTRODUCTION

The beginning of the century reinforced the relevance of a discipline that would, ideally, contribute to improve human conditions all over the world. Design was, therefore, consolidated under that intentions and design education linked the traditional knowledge of making and creating, with the machine advent, to serve the industrial development and economic prosperity best purposes. Bauhaus choices, only after a few years of existence, affirmed these intentions. Not just the learning-driven educational experiences through which Basic Design pioneered the professional level of education were abandoned but was favored a result-oriented school. A strong link with industry and the economy was set, which also ensured survival to the school [1].

Nevertheless, Itten's pedagogical approach was kept alive until nowadays through subsequent versions of Basic Design. Despite being worldwide considered an important pedagogical part of design education, the revision of related curriculum is urgently recommended [2]. As the definition of "product" includes much more than tangible objects, such as services, systems, discourses, interactions and experiences, the designer, creator of interfaces that mediate everyday action, is demanding learning tools to face the increasing complexity of world phenomena with creativity, strong

personal values and ethics. In this sense, research addressing the influence of the Basic Design classical schools (Bauhaus, Vhutemas, Chicago Bauhaus, and Ulm schools) in the present design education scenario should continue [2] offering learning design the opportunity to deliver more effective products [3].

The purpose of this study is to provide such a contextualization within the Portuguese design education scenario. It will allow the characterization of Basic Design in the present design courses, specifically, the identification of the Curricular Units - CU that continue the Basic Design tradition. This step will be followed by pointing the Learning Outcomes from the selected CU, which will set the goals for the design and testing a Virtual Reality-based pedagogic tool. This is the main objective of a research aiming concrete and effective improvements to the design teaching and learning experiences, such as the one we inevitable envision by the introduction of Virtual Reality [4]–[7].

1.1 Basic Design legacy

The first teaching-learning experience in Design, at 1919 newly created Bauhaus Design School, converges with the genesis of Basic Design Course. It also marks the beginning of the process that lead to the institutionalization of design activity during the thirties [8]. Considered the main novelty of the Bauhaus School [8], and perhaps, “its most important educational innovation” [1, p. 44], the *preliminary*, or basic course, spread its influence internationally for the last century and is affirmed as one of the most important aspects of the design teaching [2], [9]–[11].

At Bauhaus, the contact with abstraction and experimentation allowed that the new discipline of Design supplanted the insufficient official practices, making them correspond to the needs of the new professionals [12]. It is noticed the influence of Floerbel and Montessori in the pedagogical experiences lead by Itten, at Bauhaus, as a factor of innovation at professional teaching level. Also Dewey's school of thought, that seemed to be directly translated, was for the first time, brought from progressive education to higher education [1].

The expression Basic Design addresses a specific pedagogical approach, related to the way design fundamentals are taught and learned, traditionally, by freshmen students. It addresses elements of shape, colour, texture, light, and rhythm integrated in aesthetic and formal exercises that requires a holistic, creative and experimental methodology and where the technical and physical factors are not expected to be considered.

A rebirth of Basic Design education seem to have started in the beginning of the millennium, through debates and pedagogical propositions, confirmed by the use of pedagogical approaches similar with the teaching of the great design schools, as identified at an international study [2, p. 14].

1.1.1 The classical references

Design is still considered a creative activity [13]. The first teaching and learning experience lead by Johannes Itten (1888-1967) consisted in supporting that same idea, providing the adequate methodology which included the training of intuition and the cultivation of self-knowledge, for he believed that an “outward looking scientific research and technology must be balanced by inward looking thinking and by spiritual forces” [14, p. 9]. Intuition, as a superior perception, requires contemplation and self-observation, leading the way to creativity. These methods can be presently considered under the scope of the newly created contemplative pedagogy, as they prepare body and mind for productive classes and better results [15].

Continued by László Moholy-Nagy (1895-1946), firstly replacing Itten, in 1923 and after 1937, at New Bauhaus of Chicago, Basic Design continued to use Bauhaus general structure: The preliminary course, in the first year was developed through activities aimed at the ability to express the design elements (line, shape, color, space, movement, texture, volume) in various media, starting with tangible two-dimensional and three-dimensional (pen, pencil, paper, clay, wood); and then, intangible (light, space and sound). These explorations were required for developing visual intelligence, as they are strongly recommended for the present century for allowing the understanding and transformation of the invisible relations between system's elements, in all its complexity [11, p. 14]. The introduction of technological arts and the adding of science to the “Technology and Art” Bauhaus moto was essential for the new vision of the designer as an integrator [16]. This updated scenario brought the proposal for the inclusion of ethics and technoethics [17] in design learning, where intuition will continue to be mandatory for grasping the impact of the technological solutions.

The intensity and consistency of the abstract exploratory exercises, more geometric-based in the case of Marcolli (1930-2010) [18] are absolutely essential for his project propedeutic training. According to Munari (1907-1998) for effective learning is important to deepen all the topics despite that may seem not relevant to enthusiastic young people, who would prefer to draw projects immediately or play instruments [18], [19].

1.2 The genesis of Portuguese formal design education

Portuguese Design Education has considerably grown the number and variety of courses since the first pedagogical experiences, during the last sixties around the "not yet" discipline of Design. It was in 1971 that the word "Design" was officialised, at the *I Exposição de Design Português* [20]. In the previous two decades, Escola de Artes Decorativas António Arroio – EADAA, largely contributed to the transformation of the Portuguese artistic teaching [21] preparing the way to design pedagogy. In this sense, the initiative of Lino António (1898-1974), Frederico George (1915-1994) and Daciano da Costa (1930-2015), with the support of other teachers at EADAA, managed to overcome the outdated and narrow minded academic teaching based in the *Beaux-Arts* tradition. Finally, some aspects of the *Arts and Crafts* movement filtered by the Bauhausian legacy were introduced in the Portuguese educational system [12], [21].

Two pedagogical experiences marked the genesis of formal design education in Portugal: starting in 1965, the *Curso de Formação Artística*, at Sociedade Nacional de Belas Artes - S.N.B.A.; and at 1969, the Instituto de Arte e Decoração - IADE [12], [21].

Also important were another type of learning experiences, such as the ones promoted by the *Instituto Nacional de Investigação Industrial – INII*, a national institute created for the development and modernization of the Portuguese industry. It aimed the inclusion of design through some of the following actions of *Núcleo de Arte e Arquitectura Industrial*: short professional courses in the scope of design; *I Quinzena de Estética Industrial*; and simultaneously the *Exposição Internacional de Design Industrial*.

Despite the different natures of the mentioned episodes, all exemplify the non-formal learning mode that coexisted and complemented the dominant informal design learning¹. Accordingly, the master-disciple relation begun a coexistence with the non-formal learning, enabling a self-learning process.

The design courses created, first in a private context, by *Instituto de Arte e Decoração - IADE*, at 1969, and subsequently, in the public *Escola Superior de Belas-Artes de Lisboa - ESBAL*, at 1974, were certified by the Ministry of Education during the seventies and eighties, respectively. The official recognition of the *Curso de Design de Interiores e Equipamento Geral*, from IADE, renamed then, *Escola Internacional de Decoradores, Artistas Gráficos e Designers* happened in 1979² [22] and for the ESBAL courses, in 1983 [12]. Formal design education had finally started.

1.2.1 The first Basic Design pedagogical experience

The first reference to a Basic Design course in Portugal can be assigned to Daciano da Costa. The designer and teacher at EADAA undertook, in his own workshop, between 1962 and 1964, a pedagogical experience of private teaching [23]. According to Souto [24], the course was developed in the scope of Basic Design where the design problems were analysed according a bauhausian structure: the approach of the genesis of the form was based on an experimental didactics informed by Itten's theories of color and form and also influenced by Laszlo Moholy-Nagy e Josef Albers.

In this sense, these are considered important references as highlight the first steps in a Portuguese Basic Design tradition.

¹ Underlined by Victor de Almeida at *O Design em Portugal, um Tempo e um Modo. A institucionalização do Design Português entre 1959 e 1974* (doctoral thesis), 2009, the educational dimension in the Portuguese Design, can be organized according a model that establishes three educational categories: informal learning; non-formal learning; and formal education. Accordingly, informality marked the education mainly oriented at the workshops of the masters and in the context of the projectual activities. Non-formal design education implied an organized and systematized educational activity developed out of the formal educational system, such as free courses for professional specialization, workshop classes, seminars and formation sessions. Finally, formal design education requires the attendance of design courses in educational institutions and involves certification by the public organs and social recognition.

² Resolução n.º 171/79 da Presidência do Conselho de Ministros – Gabinete do Primeiro-Ministro. Diário da República 127/1979, Série I de 1979-06-02, n.d.

1.2.2 Pioneering design education

IADE is frequently considered the pioneer institution for teaching design in Portugal since the courses and seminars organized by the institute in the beginning of its existence and developed out of the workshops and corporations environments, largely contributed to open the debate around the discipline [12]. In this sense, the theory produced by Bruno Munari and Marcolli, who oriented seminars at IADE in the seventies and eighties, largely contributed to the pedagogical options at the institute. Also, during 1977, Bruno Munari worked with the school teachers analyzing IADE's program, "resulting in flagrant improvements in the curriculum, its content and methods." [25, p. 18].

At IADE, Basic Design was consistently integrated in the design curricular plans, from 1979 until the biannual scission, implemented in 2002-03 [22]. After the implementation of Bologna process, two CU replaced the annual Basic Design: *Análise Morfológica* and *Análise Cromática*. Later, in 2010-11, the institute replaced both for, respectively, 3D Design and 2D Design, continuing until the present days with the same structure, but adopting the names *Laboratório de Design 3D* and *Laboratório de Design 2D*. Neves[22] analysis revealed that the Basic Design tradition continues within this model, in two different ways: adopting a more abstract and generalistic approach to the morphologic studies, in the case of the 3D, and a more projectual character for the 2D studies.

In general, the most significant design teaching models considered for the implementation of design courses in the public high education, in Portugal, were taken from Bauhaus, Hochschule für Gestaltung, Ulm, in Germany and Basel School of Design, Switzerland. [12, p. 161]

1.2.3 Present Design Education

Deepening into to the present scenario of High Education and focusing the curricular plans of each existing course, Basic Design can be considered inexistent if only the precise expression is sought. Having considered examples, like IADE, with the present biannual CU, *Laboratório de Design 2D* and *Laboratório de Design 3D* complementing each other in the content while applying the principles addressed during the annual Basic Design CU, a detailed analysis is required to identify its presence in the Portuguese Design High Education system.

2 METHODOLOGY

This study seeks the characterization of the Portuguese High Education Design courses related to the presence of Basic Design. To achieve this purpose, we started by analysing the main literature related to Basic Design, specifically, the documents produced by the design teaching pioneers that largely influenced the birth of Portuguese design education.

A matrix was created to highlight its main concepts and characteristics, (i.e., objectives, contents and methodologies) for subsequent identification in the current CUs, at the Portuguese design courses.

Simultaneously, the curricular plans of all design courses were collected from the institutional websites. In a first glance, a pre-identification of possible CUs relating to Basic Design was made, based on the workload/ECTS and the names of the CUs.

Followed the collecting of the pre-selected Curricular Unit File - FUCs using institutional website information, and when not available by this mean, requested by email to the institution. In some cases, a formal request was sent to the pedagogic organ, as required by the academic institute.

The gathered data allowed the matching of the concepts, in several degrees of combination. Complementarily, each FUC was also analysed subjectively since only a global understanding of the parameters could allow the necessary information for the selection.

2.1 Tools for Basic Design content analysis

2.1.1 Data codification

Due the different characteristics of the design courses (e.g., general and specialized according four different areas) the codification of the respective FUCs followed the *Classificação Portuguesa de Profissões (CNP)*, a Portuguese professional classification [13]: *Design de Produto Industrial ou de Equipamento (DPIE)*; *Design de Têxteis e Moda (DTM)*; *Design de Interiores, Espaços ou de Ambientes (DIEA)*; and *Design Gráfico de Comunicação e Multimédia (DGCM)*. We added Generic Design to the list since the object being analysed is not related to professional activities, but High

Education design courses that offer more generalists approaches that frequently address all areas in a superficial way, opening to future specialisation, (e.g., by taking a master-degree course.)

Respectively, the identification of each FUC includes the abbreviation of the specialization area numbered sequentially according our list, followed by its name (e.g., DPIE_8-Introdução ao Design)

2.1.2 Matrix

From the main literature produced by the design teaching pioneers that largely influenced the birth of Portuguese design education, including Basic Design, were identified the parameters: Basic Design concept; objectives/learning outcomes; teaching and learning methodologies; and programmatic content.

The main references include the ones used by Daciano da Costa, for the creation of an informal Basic Design course at his workshop, in the sixties; IADE's references for the Italian influence on the seventies and eighties, and finally, the significant design teaching models considered for the implementation of design courses in the public high education. The references considered are Johannes Itten [14], the most representative element of the Bauhaus Basic Design Course, Hochschule für Gestaltung, Ulm, in Germany, through Gui Bonsiepe [8]; Basel School of Design, Switzerland [12]; László Moholy-Nagy [16]; Josef Albers; Bruno Munari ([19], [26] and Marcolli [18], [27]. A conceptual mapping is advanced according "Table 1".

Table 1. Conceptual mapping.

Objectives/learning outcomes	Pedagogical methodologies	Programmatic content
- self-confidence - discover the self - discover self-talent - original/genuine work - develop individual - discover potential - make career choices - discover comfort levels in materials and media - creativity - train experiences - train perceptions - courage - remove deadwood of convictions - explore - intuition - produce or execute with quality - express design elements in various media and techniques - abstract	- experience with the senses; objectivising these at an Intellectual level; and realising these through synthetic means - theory and practice of polar contrasts - media explorations - relaxation exercises - concentration exercises - message decomposition - practical-theoretical - sensory stimulation and training the senses - develop four successive fields: geometric-intuitive; gestalt; topological; and phenomenological - transformational geometry: Euclidean; affine and projective; topological; and set theory	- theory and practice of polar contrasts - laws of form (expressive, subjective, complex) - texture - rhythm - chiaroscuro - materials - media - composition principles - laws of colour, contrasts - laws of form - line - shape - space - movement - volume - formal coherence - modularity - symmetry theory - morphogenesis - closepacking

2.1.3 List of Portuguese High Education design courses

For the pre-selection and following selection phase, was used an on-line institutional list³ with all the Portuguese High Education design courses. The list consisted of a total of 61 design courses, where

³ <http://www.dges.mctes.pt/DGES/pt/estudantes/rede/ensino+superior/estabelecimentos/rede+privada> retrieved January 2017; and <http://www.dges.mctes.pt/DGES/pt/Estudantes/Rede/Ensino%20Superior/Estabelecimentos/Rede%20P%C3%BAblica/> retrieved January 2017

39 courses were from public institutions, including universities and polytechnics, and 22, from private universities and polytechnics. Data collecting took place during the academic year 2016-17 and referred to that period.

3 RESULTS

3.1 Pre-selection of possible Basic Design-based CUs

The pre-selection phase considered the 61 design courses originally listed. The websites of the institutions provided the curricular programs, which were checked for CUs with high workload/ECTS, and for designations that, in the whole set of CU could indicate the presence of Basic Design. To state few examples, were pre-selected the following CUs from the first-year curricular programme of a given design course: Generic_2-Design I; and Generic_2-Design II-Generic_2 due the highest workload and ECTS from all the 12 semester CUs. We followed the same criteria with DGCM_3-Design Gráfico 1; and DGCM_3-Design Gráfico 2, from the 14 semester CUs.

The FUCs, were searched at the institutional websites, and, when not available, a formal request was sent to the respective institution. Were gathered 45 courses, 91 FUCs (28 public design courses with 61 FUCs; and 17 private design courses with 30 FUCs). The detailed analysis of the FUCs was not possible for 16 courses due the lack of reply by the contacted institution, and, in a few cases, due the discontinuation of the course.

3.2 Selected Basic Design-based CUs

3.2.1 Collected FUCs

The main selection phase used the 45 design courses previously mentioned. As resumed in "Table 2", the FUCs related to Basic Design reduced considerably after detailed analysis, causing also, a reduction of Design Courses that incorporate Basic Design FUCs.

Table 2. Selected FUCs.

	Pre-selected FUCs available				Selected FUCs			
	Public		Private		Public		Private	
TOTAL	28 courses	61 FUCs	17 courses	30 FUCs	19 courses	24 FUCs	16 courses	22 FUCs
Generic	4	10	6	9	2	4	6	9
(DPIE)	8	18	1	1	6	7	1	1
(DTM)	2	4	1	1	0	0	1	1
(DIEA)	2	5	1	1	1	1	1	1
(DGCM)	12	24	7	18	9	12	6	10

It was interesting to observe that only DPIE_6 Projeto em Design Básico, includes Basic Design expression in its designation. All the others reveal different names (e.g., DGCM_15 Forma e Cor; DGCM_17 Introdução ao Design; DIEA_1 Laboratório de Matéria e Forma)

3.2.2 Expose and eliminate bias

Although identified at some CUs, topics frequently related to Basic Design (e.g., the basic elements of the visual language (form, plane, surface, colour, space, volume, mass, scale, high, matter, light, shadow, texture) and its organization principles, such as in Desenho-DGCM_1) the lack of other significative Basic Design elements or, the main focus on the drawing abilities, techniques and materials, determines it's selection. In this case, as in similar ones related to the development of a specific mode of digital representation, such as DGCM_1 Design 3D, the CUs are not selected as continuing Basic Design tradition.

Also, after closer analysing the pre-selected FUCs, some were immediate excluded due to its strong projectual character (e.g., DGCM_8 Design de Comunicação II; Generic_3 Design II; DGCM_13 Design de Comunicação I; and others). Whenever was perceived the dominance of projectual thought

and practice and focused the final result, plus a lack of experimental approach to fundamentals, the CU was not considered for passing the selection phase.

The same situation is verifiable for theoretical approaches, as in Generic_1 Teoria e Prática do Design, or at DGCM_15 Projeto e Metodologia.

4 CONCLUSIONS

Public and private Portuguese design courses that continue Basic Design tradition can be considered a total of 35, being 19 public courses and 16 private courses. The respective 24 and 22 FUCs revealed a set of concepts and ideas related to Basic Design, present at the objectives, methodology and content.

Besides allowing the identification of Basic Design-based CUs, the matrix and collected FUCs can be used to assess, in a more precise manner, some other aspects that may inform learning design about ways to improve the learning of freshman design students, such as, to map the learning theories underlying each CU and respective course.

Marculli and Munari have once reinforced the need for intensely exercising and exploring the elements of design and its combinations. That propedeutic training, although contradicting young people's will for quick results, that is, for immediate products creation, was mandatory for consolidating the design fundamentals and consequently, for delivering better professionals. Presently, as already noticed, the amount of FUCs not selected for adopting a projectual approach was considerable. Besides, most of the selected ones also integrate both abstract exercises and a final project. Can we deduce less quality pedagogies are being available to satisfy students impetuosity? Or, on the opposite, research revealed students equally learn in the two conditions?

4.1 Renewing/reviving Basic Design?

Noticed the presence of Basic Design in the Portuguese High Education system, it is however important to take in account missing aspects, presently considered by researchers in the educational field, as providers for better experiences and effective learning. Missing topics relate, particularly, the inclusion of new technologies, like Virtual Reality, as well as the ancient contemplative practices, both proven to contribute to learning and equally providers of a useful sense of presence, to learning experiences.

Technology, namely, Virtual Reality, is not present as part of Virtual Learning Environments for delivering Basic Design topics. Nevertheless, the use of software is often, one of the means through which students can develop their exercises. Multimedia is also sometimes used to present contents. Additionally, the use of social platforms, such as the institutional ones (e.g., DPIE_6 Projeto em Design Básico, mentions the platform FLICKR), are rarely referred as part of the methodology approach, probably used for promoting discussion between the groups of students, or simply, a form of delivering the exercise for assessment by teachers.

Although the evidence of in-existent breathing and concentration exercises in Portuguese Basic Design CUs we suggest that designers can benefit from the revival of some missed important aspects related to Basic Design pedagogy. At its initial moment, one of Basic Design main purpose was the development of intuitive thought. In this days there is much value added to intuition since it can help the comprehension of complex systems in which all human activities are involved, from medicine to law [17]. Through time, this intention was lost, originating more rational and formalistic exercises.

However, it is important to highlight some elements in the FUCs that suggest contemplative approaches. That's the case for the DPIE_6 Projeto em Design Básico, a CU selected as a Basic Design UC. As part of the methodologic approach, is required a diary where students register their work progressively. It promotes the habit of reflecting about previous work, without corrections or revisions, an approach considered by contemplative pedagogy.

As designers are the enablers of human flourishing (i.e., to design experiences that convey to people a sense of well-being related to the feeling of being aligned with values and ideas that positively contribute to a common good [28]) wouldn't we all benefit from adding such ancient methodologies on present design learning? Because "In design, character counts" [29, p. 263], being a designer requires "lifelong commitment to one of the most important design processes you can engage in — the design of your own life." [29, p. 263]

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REFERENCES

- [1] A. Cross, 'The educational background to the Bauhaus', *Des. Stud.*, vol. 4, no. 1, pp. 43–52, Jan. 1983.
- [2] C. G. Boucharenc, 'Research on Basic Design Education: An International Survey', *Int. J. Technol. Des. Educ.*, vol. 16, no. 1, pp. 1–30, Jan. 2006.
- [3] Pearson School of Design, 'Using Learning Design to Build More Effective, Engaging Products'. 2016.
- [4] K. Colucci, 'What role will technology play in the future of design education', in *Icograda Design Education Manifesto 2011*, 2011, pp. 63–67.
- [5] A. G. Neves and E. Duarte, 'Using Virtual Environments in Basic Design Education', in *Senses & Sensibility'15: Design as a Trade Proceedings of the UNIDCOM/IADE 8th International Conference*, Lisboa, Portugal, 2015, pp. 273–280.
- [6] A. G. Neves and E. Duarte, 'Using Virtual Environments in Basic Design Education', *Radix Des.*, no. Senses & Sensibility'15 ThRAD Special Issue, Feb. 2016.
- [7] A. G. Neves *et al.*, 'Learning Basic Design with Virtual Reality: A methodological approach', in *EDULEARN16 Proceedings*, Barcelona, 2016.
- [8] G. Bonsiepe, *Teoria e prática do design industrial: elementos para um manual crítico*, 1992nd–1ª ed portuguesa ed. Lisboa: Centro Português de Design, 1992.
- [9] G. Anceschi, 'Design di base: fundamenta del design', *il verri 'newbasic'*, no. 43, 2010.
- [10] C. Cetinkaya, 'Basic Design Education Parameters in Turkey', in *Humanitas International Journal of Social Sciences*, Central and Eastern European Online Library, 2014, pp. 31–46.
- [11] A. Findeli, 'Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion', *Des. Issues*, vol. 17, no. 1, pp. 5–17, Jan. 2001.
- [12] V. Almeida, 'O Design em Portugal, um Tempo e um Modo. A institucionalização do Design Português entre 1959 e 1974', doutoramento, Faculdade de Belas Artes, Universidade de Lisboa, Lisboa, 2009.
- [13] D. Agapito, H. Almeida, M. Cesário, S. Fernandes, and A. Lacerda, *Design em Portugal – O perfil do designer e o papel do design nas empresas em Portugal*. Faro, Portugal: Sílabas & Desafios, 2015.
- [14] J. Itten, *Design and Form: Basic Course at the Bauhaus*, Revised edition edition. London, England; New York: Titles Supplied by John Wiley & Sons Australia, 1975.
- [15] D. P. Barbezat and M. Bush, *Contemplative Practices in Higher Education: Powerful Methods to Transform Teaching and Learning*, 1 edition. San Francisco: Jossey Bass, 2014.
- [16] L. Moholy-Nagy, *Vision in Motion*. United States of America: Wisconsin Cuneo Press, 1947.
- [17] A. Findeli, 'Ethics, Aesthetics, and Design', *Des. Issues*, vol. 10, no. 2, pp. 49–68, 1994.
- [18] A. Marcolli, *Teoria del Campo - corso di educazione alla visione*, 1998th, 17ªed ed. Milano: Sansoni Editore, 1971.
- [19] B. Munari, *Design e Comunicação Visual*, 1 edition. São Paulo: Martins Fontes, 1998.
- [20] A. S. da Silva, 'Modos de aprender', in *Daciano da Costa Designer*, Fundação Calouste Gulbenkian., Lisboa, 2001, pp. 12–17.
- [21] M. H. Souto, *História do Design em Portugal I*, Edições IADE. Lisboa, Portugal, 2009.

- [22] A. G. Neves, 'Basic Design at IADE: Drawing the line', presented at the Design Doctoral Conference - DDC'18, Universidade Europeia, IADE, Lisboa, 20-Jun-2018.
- [23] D. da Costa, 'Curriculum Vitae'. 2001.
- [24] M. H. Souto, 'Daciano da Costa e o ensino do Design em Portugal', in *Daciano da Costa Designer*, Fundação Calouste Gulbenkian., Lisboa, 2001, pp. 34–41.
- [25] IADE – Instituto de Artes Visuais, Design e Marketing, 'Requerimento para autorização de criação e funcionamento da Escola Superior de Design e da Escola Superior de Marketing e Publicidade'. (documento interno), 1989.
- [26] B. Munari, *Arista e Designer*. Lisboa: Editorial Presença/Martins Fontes, 1979.
- [27] A. Marcolli, *Teoria del Campo 2 - corso di metodologia dalla visione*, 1991st, 3^a ed. ed. Itália, Firenze: Sansoni Editore, 1978.
- [28] P. Desmet, A. Pohlmeje, and J. Forlizzi, 'Design for Subjective Well-Being', *Int. J. Des.*, vol. 7, no. 3, pp. 1–3, 2013.
- [29] H. G. Nelson and E. Stolterman, *The Design Way: Intentional Change in an Unpredictable World : Foundations and Fundamentals of Design Competence*. Educational Technology, 2012.

BACK TO THE BASICS OF BASIC DESIGN: THE PORTUGUESE SCENARIO

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Abstract

In recent years, the foundations of design teaching and learning have been subject to revision and reinvention, particularly concerning the way the discipline is introduced to students. Against that backdrop, the present study focuses on Portuguese Design study programs to identify the presence of Basic Design tradition, specifically concerning the Learning Outcomes (LO) stated in the course programs. Despite the changes occurred in the Higher Education system since the birth of Basic Design course, it has continually affirmed itself worldwide as a course with distinctive characteristics. Basic Design is considered an introductory course to the Design principles, targeting the first-year undergraduates in Design. It applies experimental methodologies that promote creativity, using practical exercises and the free exploration of different materials and techniques; addresses programmatic contents that include the principles of 2D and 3D design, such as symmetry, formal coherence, modularity and standardization, and others attributed to the visual arts, such as the Gestalt laws; and aims at LOs such as the design of objects according to parameters that are more aesthetic than technical, more personal than content-specific. Considering the inevitability of Basic Design evolution (imposed by the technologic migration, such as the introduction of Virtual Reality in the classroom, a detailed map of the Portuguese Basic Design teaching and learning scenario may contribute to effective learning activities. Therefore, courses that carry on the Basic Design tradition were analyzed quantitatively according to the integration in: (i) the public versus private sector; (ii) the university versus polytechnic system; (iii) general versus specialization of Design study programs (i.e., the categories used by the Portuguese professional classification: Industrial, Product or Equipment Design - *DPIE*; Textile or Fashion Design - *DTM*; Interiors, Space or Environment Design - *DIEA*; Graphics, Communication and/or Multimedia Design - *DGCM*; and the General Design - *DG*, named by us). Complementarily, the theoretical model created by John Biggs (i.e., constructive alignment) for supporting the design of learning and teaching activities pointing the ILOs - Intended Learning Outcomes, was considered for analyzing the LOs. These were lexically categorized according to the 3 dimensions that compose LOs: the content topics; the levels of understanding (i.e., high level versus low level) as defined by SOLO Taxonomy; and as being general versus content-specific. Finally, a qualitative methodology, which required the use of MaxQDA software for content analysis, was applied. It allowed to conclude the distinctions and similarities in the use of LOs (3 dimensions) by Basic Design courses in the Portuguese Design education scenario. A global perspective is presented, but also, according the sector, system and study program types. The variety and multiplicity of scenarios identified in this study will allow, more than a general view of the LOs currently found at the Portuguese Design study programs, the possibility to set up learning experiences and environments that better suit first-year students and helps them learn and perform each ILO. Specifically, it will inform the next phase of our research about the LOs that a VR-based tool can/should address.

Keywords: Portuguese Design Education, Higher Education, Basic Design, Learning Outcomes, Virtual Reality.

1 INTRODUCTION

In the Portuguese context, the influence of Johannes Itten's centenary pedagogical invention, Basic Design, has been highlighted in recent studies that specifically address the Portuguese higher education Design study programs [1], [2]. Internationally applied and adapted to the present times [3], the pedagogical approach was kept alive until nowadays through subsequent versions. In general, Basic Design corresponds to a specific pedagogical approach that addresses the way design fundamentals or the Principles of Two-and Three-dimensional Design are taught and learned. Some debates at the

beginning of the century promoted a rebirth of Basic Design education. That same idea can be confirmed by the present use of pedagogical approaches similar to those developed in the past by a few of the great design schools, as identified at an international study by Boucharenc [4]. Despite being worldwide considered an important pedagogical part of design education, its roots on the Design classical schools (Bauhaus, Vkhutemas, Chicago Bauhaus, and Ulm schools) should be revisited for updating the present design education [5] aiming the inevitability of the introduction of Virtual Reality and in the wider definition of "product", which includes more than tangible objects, such as services, systems, discourses, interactions and experiences [6].

To set the ground and guidance to a design education renewal in respect to the ways the first-year undergraduates in Design are introduced in the discipline, this study participates on a large ongoing research that focuses innovative approaches in Design education involving VR-based tools. The first part of the research consists in mapping current Basic Design learning outcomes by analysing the study plans of the Portuguese Design study programs. The second part will consist of a case study in which a VR tool will be prototyped and empirically tested in IADE's study programs, according to a User-Centred Design approach and using a mixed, quasi-experimental design. The potential of the VR-based tool will be evaluated by comparing the performance of two groups of students, expecting to improve competences acquisition and satisfaction, and, consequently, enhance the Basic Design teaching-learning process.

The first part already resulted in a synchronic analysis, which allowed the identification of Basic Design courses in the Portuguese higher education system [1] and a diachronic analysis, which revealed the presence and evolution of Basic Design over fifty years of the Design study programs at IADE [2]. The study now presented closes that first part by deepening into the LOs of the Basic Design course programs. An amplifying lens provided by constructive alignment theory allowed the characterization of the LOs for the subsequent phase of the tool creation, by specifically addressing the two main components of each LO: the action (verb) and the content (subject). The 3D matrix that resulted is expected to assist Design educators in several pedagogical activities, such as the creation of learning tools for specific learning outcomes.

2 BASIC DESIGN

Since Bauhaus Design School (1919-1933), Design education has consolidated its presence in the world. The *preliminary*, later called *basic course*, was considered one of this school's main pillars [7] and, in the opinion of Cross [8], Bauhaus' most important educational innovation. Basic Design was created by Johannes Itten (1888-1967) as a six-month study programs with the purpose of freeing and strengthening the imagination and creativity of the 1st year design students [9]. The focus on creativity and the development of personal abilities was achieved by exploring the theory and practice of polar contrasts, as well as by performing relaxation and concentration exercises. These were part of a methodology for training intuition and the cultivation of self-knowledge, since "outward-looking scientific research and technology must be balanced by inward-looking thinking and by spiritual forces" [9, p. 9]. László Moholy-Nagy (1895-1946) developed one of the subsequent Basic Design models, at the New Bauhaus of Chicago, in 1937. This design course programme kept Bauhaus' general structure, essential for promoting the designer as an integrator [10]. At Ulm School (1953-1968), science and technology were reinforced in the general model of the Design course, giving less space for artistic exploration. Subjective ways of creating forms were replaced by processes to develop formal synthesis using formal coherence. In Italy, the influence of the Ulm director, Tomás Maldonado (1922-2018), was predominant over Marcolli's theoretical proposal for a "projectual pedagogy" [11, p. 3], as presented at *Teoria del Campo* [11], [12]. It consists of a propaedeutic training for developing the visual perception through four successive fields/spaces: geometric-intuitive; Gestalt; topological; and phenomenological.

2.1 Portuguese Design education: Basic Design

The first pedagogical design experiences in Portugal took place during the 1960s, despite the word "Design" only becoming official in 1971 at the "I Exposição de Design Português" [13]. Two pedagogical experiments marked the origin of formal design education in Portugal: the "Curso de Formação Artística", at "Sociedade Nacional de Belas Artes - S.N.B.A.", which started in 1965, and the "Curso de Decoração de Interiores", in 1969, at "Instituto de Arte e Decoração – IADE" [14], [15].

The first Portuguese reference to Basic Design is the pedagogical experience created by the designer and, at the time, teacher at EADAA, Daciano da Costa. Between 1962 and 1964 he undertook, in his own workshop, a private teaching course [16]. In the case of IADE, Basic Design was consistently integrated in the Design study programs from 1979 until the 2002-03 biannual scission. Different

designations were found since that moment, depending on the topics of subsequent courses. Accordingly, results point to a present structure that derives from the morphologic and chromatic studies included in Basic Design since 1979, which, in turn, continue Johannes Itten centenary heritage [2].

3 LEARNING OUTCOMES

3.1 The designer's competences

While addressing the design skills needed for a time horizon, a research by Gomes [17] considered the perception of designers and lecturers in design about the relevance of design skills in three key moments: academic training; working experience; and a specific time horizon, 2015. The study revealed that the skills recognized as most developed in training are, for the most part, those of the personal skills group, which also evolve significantly in the other two key moments. Designers emphasize as their main focus of their academic learning the mastery of personal skills. They also mention some acquisition of more theoretical knowledge of the Design fundamentals, among others. The importance of mastering the fundamentals of Design (structure, shape, color space) is also mentioned by designers as a specific competences in a future horizon, next to: *mastery of visual language, namely in terms of color, shape, style, dimension; ability to plan and execute Design projects; ability to propose technical, aesthetical and functional solutions for spaces, products or artifacts made by them; and ability to find alternative Design solutions and evaluate them* [17, p. 125]. In fact, all the mentioned competences can be addressed in the first-year study program, at Basic Design course programs, despite the high level of mastery is only due by the end of the total academic cycle. However, the design fundamentals are what define, in a great part, Basic Design course programs [1].

3.2 Learning Outcomes

Learning outcomes - LOs, also identified as: academic goals; expected results; and learning objectives, stand for what learners should know or do as a result of a learning process [18]. Thereby, LOs *"could be conceived as statements which describe a desired condition – that is, the knowledge, skill, or attitude expected"* [18, p. 1], precisating at the same moment how the achievements will be assessed. Learning outcomes is a concept based on the competences [19], but not overlapped. A set of knowledge, skills, and competences are embodied in the LOs, which also include values, beliefs, and attitudes expected to be achieved by students [18]. LOs is the manifestation of the Bologna Declaration impact in the Higher Education system, having become a familiar and relevant expression among all the actors. Next to and aligned with assessment methodologies and curricula design, LOs constitute the "Framework for Qualification of European Higher Education". This European common structure allows the comparison between study programs and higher education institutions in Europe. The several qualification levels of the Framework are defined according a learning outcomes approach [19], which also allow the improvement and development of institutions and policies within education, specifically, higher education. For the purpose of this study, it is emphasized the importance of the LOs for directing the design of a learning activity by focusing the required changes on the learner's performance; in establishing guidelines for content, instruction and evaluation; in explicitly recognizing what is to be learned; and in delivering to learners exactly is to be accomplished.

3.2.1 Constructive alignment theory

The enhancement of teaching and learning that focus the outcomes is often referenced as outcomes-based teaching and learning (OBTL) [20]. Constructive alignment is usually used under that scope. Created by John Biggs [20] the constructive alignment theory is based on the constructivist theory of learning due the emphasis on the students tasks to construct knowledge, and on the *"alignment between the intended learning outcomes, the teaching/learning activities and the assessment tasks."* [20, p. 50]. The design of learning activities, in constructive alignment, ensures the presence of the intended verb in the outcome statement, in the teaching/learning activity and in the assessment task [37]. It means focusing on what and how students are to learn, that is, the act upon a specific topic that the students should be engaged in, which manifests and consequently, allows, their qualification, through assessment. The intended learning outcomes are, therefore, the key of the whole system. As highlighted by Biggs [21], the desired outcomes of teaching specify the performance of understanding according a four levels criteria: the level of understanding that students should achieve in terms of a topic content. SOLO taxonomy reflects the structure of levels of understanding, with a list of appropriate verbs. Two main categories that represent a quantitative phase of learning needed for the follow up qualitative phase, are attributed the *low level* and *high level*, respectively. The *low level* outcomes that

involve simple and quantifiable verbs are considered of *unistructural level* (e.g., such as: identify; memorize; and doing simple procedures) and *multistructural level* (e.g.: enumerate, describe, list, and so on). As for the quality phase, which implies that the quantitative phase was acquired, the *high level* outcomes are subdivided in *relational level* (e.g.: compare/contrast; explain causes; analyze; apply; etc) and *extended abstract level* (e.g., when the verbs involve: crating; theorizing; reflecting; grounding; etc). There are appropriate levels for each year level taught, and in the case of Higher Education system, intended outcomes would be predominantly high level.

4 METHODOLOGY

Aiming the identification and characterization of the Portuguese Design study programs in terms of Basic Design LOs, a 3-D matrix was created using the theory of constructive alignment, for which the following categories were established: content; levels of knowledge; and generic/specific. The matrix was applied to the Portuguese Basic Design course programs using MaxQDA software for content analysis. The units of text (i.e., the sentences) stated as LOs in the course programs were codified. Also, LOs present in other units of text along the course programs, which revealed the structure of a LO sentence and simultaneously complemented with relevant and/or new information the one already codified, were considered. Thus, the qualitative analysis considered the document in a global perspective.

4.1 Sample

Resulting from a previous study [1] which used a total of 61 Portuguese design study programs, 45 were analysed. From these, 35 Design study programs (77.8%) were identified as having Basic Design course programs. It resulted then, a total of 46 course programs, although a closer analysis concluded that 43 was the precise number.

The distribution of Basic Design course programs by the Portuguese design study programs is presented at *Table 1*. An overview of that distribution by the public versus private sector notices a balance, as the 22 equal, as much as possible, the private 21 (respectively, 51% and 49% from the total). Addressing the type of educational system, 27 course programs belong to the university institutions (63%), and from the polytechnic institutions, 16 (37%). Finally, the distribution of course programs along the different types of study programs, presented in absolute values at Table 1, follow the relations: 49% for Graphics, Communication and/or Multimedia Design – *DGCM*; 21% for Industrial, Product or Equipment Design - *DPIE*; 2% for Interiors, Space or Environment Design - *DIEA*; 2% for Textile or Fashion Design - *DTM*; and 26% for General Design – *DG*.

It is interesting to observe that the General Design study programs - *DG* are only represented in university institutions with 11 course programs, being 3 from the public sector and 8 from the private sector.

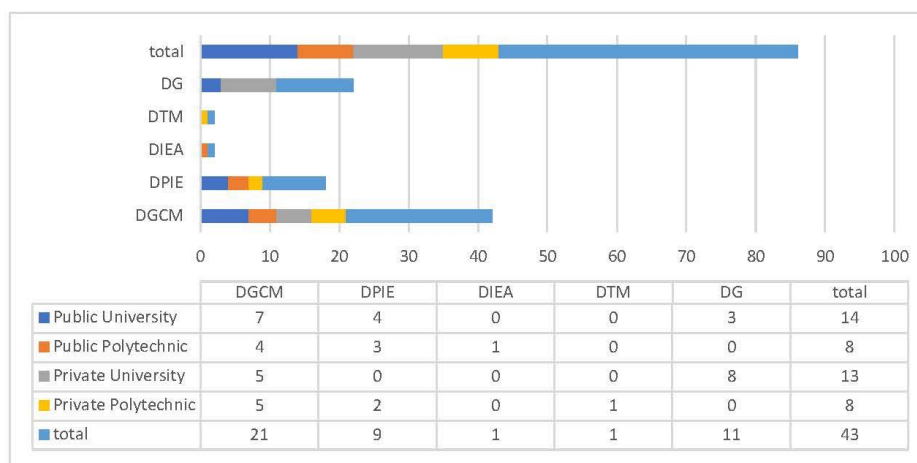


Table 1. Basic Design courses in the Portuguese Design study programs.

4.2 Procedures

The qualitative analysis undertaken required the simultaneous tasks of creating the matrix while coding the units of text, as the different codes and sub-codes derived from the main topic could only be defined relatively and as they emerged. Firstly, were coded the units of text defined in the course programs as LOs. Then, each document was analysed to identify possible LOs that complemented the already coded ones. Once identified all the LOs, they were categorized according the content topic; the levels of understanding (i.e., high level versus low level); and as general versus content-specific.

4.2.1 Creation of the 3D matrix

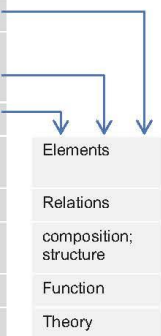
★ Contents

The creation of the lexical matrix in respect to the contents in the LOs was, partly based, on the list of specific Design competences used by Gomes [17]. Several sub-codes of categorization were identified, in a total of four, as in the case of the column that addresses elements; relations; composition; structure; function; and theory, for 3D shape (Table 2). However, for the purpose of this study, were only addressed the main codes.

Some expressions had to be defined for allowing categorization, such as the term curiosity. Was noticed to be a manifestations of creative behaviour [22, pp. 6–7], such as other qualities in varying degrees and combinations, like: people awareness of creativity; imagination; independence; and so on.

The *undefined* code was created to address all the LOs impossible to classify, even after searching any meaning in all document. That is the case of the LOs that address input capacities that cannot be manifested externally as they occur (e.g., at doc. 11: “develop the abilities: to see; to understand; to think”). In the stated example adds the fact that doesn’t involve any content.

Table 2. Portuguese Basic Design course programs: Contents in LOs

design fundamentals	form	2D shape		personal values and skills	work process	
		3D shape			creativity; curiosity; authenticity; experimentation	
		general form			criticism	
	color	general color			interdisciplinarity; multidisciplinary	
		elements			autonomy	
		composition; structure			self knowledge; self-evaluation	
		function			analysis; reflection	
		theory			observation; to see	
	fusion fundamentals (color, shape, space, etc)	elements			communication	
		relations			team work	
		composition; structure			delivery times	
		function				
		theory				
	means and techniques	analog				contexts (historical; economic; social; cultural)
		analog-digital				project; methodology
			undefined			

★ Levels of knowledge

The dimension related to the levels of knowledge in the LOs is presented on *Table 3*. As already mentioned, SOLO taxonomy [20, p. 81] presents some verbs used for the codification of LOs. To these, a few specific verbs were added from the Basic Design, (e.g., for *low1-unistructural level*: operate, manipulate, explore and exercise; *low2-multistructural level*: expose and structure; *high3-relational level*: assess; and for *high4-extended abstract level*: systematize and transform). An *Undefined level* was created due the impossibility to define the level, which sometimes, occurred in situations of LOs such as doc. 36, “*Develop sensibility for perception...*”. Displayed in such a manner it is not possible to deduce the expected behavior from students and consequently, they are coded *undefined level*. However, a clarification of the meaning was always tried and, in a few cases (e.g., when it referred “*develop analyses capacity*” and “*to know means and techniques*”, both at doc. 8) it came in the expression used in the *content* topic of the syllabus (e.g., “*Awaken the critical sense and the thought of Design project*”). It allowed the codification in *level 1* since it addresses an apparent non profound knowledge, but a more superficial contact, or mere acknowledgment of the facts.

Table 3. Portuguese Basic Design course programs: Levels of knowledge in LOs

low1-unistructural	become aware/recognize; represent/draw/manipulate/operate/exercise; identify/collect; wake-up competences; explore; sensitize; define
low2-multistructural	describe/expose/communicate; search; investigate; experiment; present; distinguish; systematize; acquire habits; structure
high3-relational	to apply; criticize/judge/decide; integrate/articulate/merge; analyze; to solve; explain/justify; debate/argue/defend; to build; organize; interpret; manage; plan; execute projects; express; synthesize
high4-extended abstract	ground; create/compose; master; design; conceptualize; reflect; generate; be autonomous; transform
undefined	vague; to understand/to know; without content

★ Generic versus content-specific

Table 4. Portuguese Basic Design course programs: Generic/content-specific in LOs

content-specific	generic	
	embedded	context free

5 RESULTS

5.1 3D matrix

The theoretical model named as constructive alignment was considered for analyzing the LOs present at the Basic Design course programs identified at the Portuguese Design study programs. It resulted in a 3-dimensional matrix presented at *Table 5*. It allowed the identification of the LOs within public versus private sector of higher education; to relate university versus polytechnic institutions; and present the types of Design study programs that requires them.

Table 5. Structure of the 3D matrix

<i>Course programs/ LOs</i>	<i>Contents (A)</i>	<i>Levels of knowledge (B)</i>	<i>General/specific (C)</i>
Public/private sector (1)	A1	B1	C1
University/polytechnic type (2)	A2	B2	C2
Design Study program typology (3)	A3	B3	C3

5.1.1 Contents

Table 6 presents the lexical matrix referent to the *content* in the main categories, as the sub-categories are not addressed in this study.

Relating the public and the private sector, both present *design fundamentals* as the prominent area of content. It deserves a note the fact that the percentage of the topic *personal values and skills*, for the private sector, equals *design fundamentals*, 90.48%. In the public sector, *personal values and skills* denote less predominance, 72.73%, coming after *communication*.

University versus polytechnic institutions show, however, a significant difference in the percentage on the topic communication: the course programs in the university present 74.7% and the polytechnic, 100%. The topics *design fundamentals* and *personal values and skills* are dominant in the university, respectively, 92.59% and 85.19%, while in polytechnics appear right after communication, with 87.5% and 75%, in the same order.

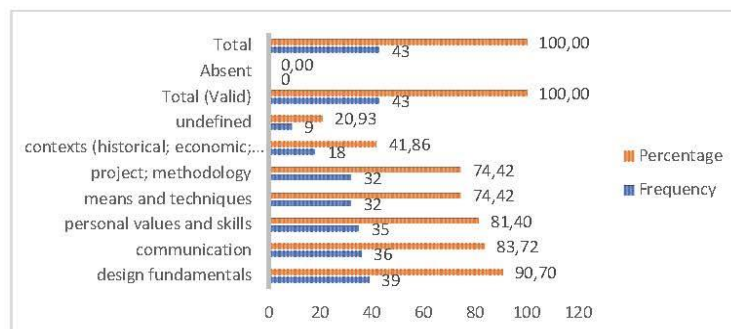


Table 6. Basic Design courses: Contents in LOs (A)

The Portuguese Design course programs address design fundamental as the most prominent content topic, with a percentage of 90.7%. At Table 7 are presented absolute values for the different specialization type. Despite a more detailed analysis relating this connection won't be made in this study, it is highlighted that DG study programs present the topics *design fundamentals* and *personal values and competences* in 100% of the course programs, being clearly above the average of the total courses. The same is happening in two other types of courses, DTM and DIEA, despite represented with only one syllabus each.

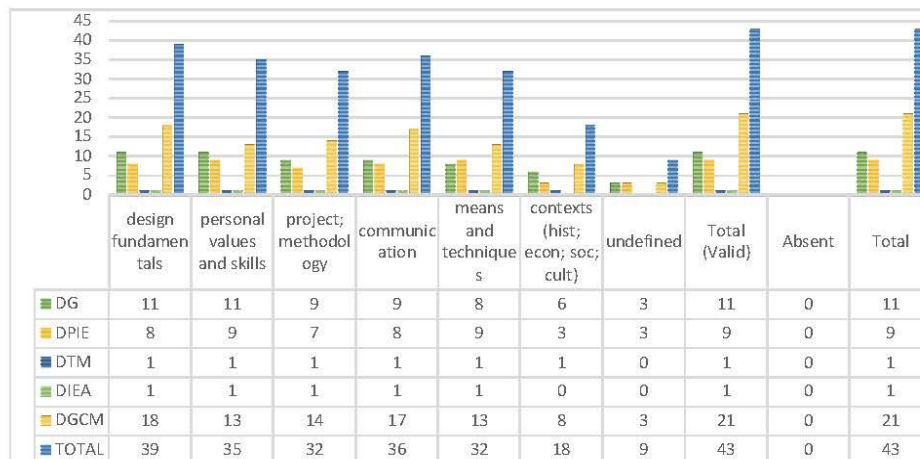


Table 7. Portuguese Basic Design course programs: Contents in LOs in Design study programs (A3)

5.1.2 Levels of knowledge

The levels of knowledge identified in the Portuguese Basic Design course programs can be noted in Table 8. The distribution of total study programs according the previously presented structure levels of knowledge defined that the *high(3)-relational* level is present in 100%, followed by the *low(1)-unistructural* level. Also should be stressed that the undefined level is present in more than 50% of the course programs.

Detailing the public/private sector, both equal the *high(3)-relational* level for the total course programs. A significant difference is noted in the second most frequent level. While the public sector reveal the *low(1)-unistructural* level, with 86.36%, the private sector presents the *high(4)-extended abstract* level, with 95.24%. This last level is only used in 54.55% at the public sector.

As to the university versus polytechnic, a salient aspect concerns the increased percentage of undefined level, 59.26%, against the drop relating the average of the study programs, to 43.75%, respectively. The same effect occurs in the *high(4)-extended abstract* level, as it rises to 85.19%, in the university Design study programs, (where it equals the *low(1)-unistructural* level), and drops to the 43.75% in the polytechnic.

At the Design study programs type categorization, almost all course programs present a balanced level distribution, varying between 100% that use *low(1)-unistructural*, *high(3)-relational* and *high(4)-extended abstract*; and 72,73% that use *low(2)-multistructural* level. The study programs that present less balance in the use of levels are the DGCM, that oscillates between 100% using *high(3)-relational* level and 42.86% using *low(2)-multistructural* level.

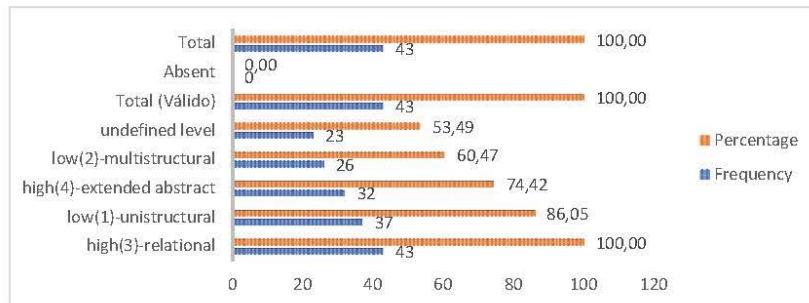


Table 8. Basic Design courses: LOs levels (B)

5.1.3 Generic/content-specific

In the generic/content-specific dimension of the analysis (Table 9), there is not much difference presented with respect to the axis public-private sector. Both are balanced distributed whatever dimension is considered.

The same can be verified in the University and Polytechnic types of institutions, respectively, 88,89% course programs have generic LOs versus 81,25%.

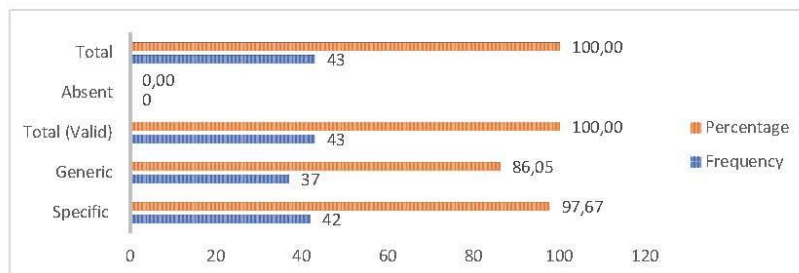


Table 9. Basic Design courses: Generic/content-specific in LOs (C)

Relatively to the Design Course type, for PDIE, all the course programs have both generic and specific LOs. The Design Courses that present the major difference in the use of both generic and specific sides of the axis are the DGCM type, where the generic counts 80.95% and the specific, 95.24%. To conclude this dimension, it is noted that all the syllabus present specific LOs, except 1, from a DGCM type of private polytechnic institute; and from the 5 course programs that remain with no generic LOs, 3 are from DGCM and 2, from DG type of Design Course.

6 CONCLUSIONS

It can be drawn from this micro-pedagogical analysis to the LOs from the Portuguese Basic Design course programs, that the content-specific *design fundamentals* present a major relevance. That fact confirms the evidences made by Gomes [17] for the overall academic training cycle of the designers, where the topic has a considerable importance, but supplemented by personal skills, as considered by the designers and design instructors. Our analysis show, specifically for the public versus private sector, that the most valued topic in the contents addresses design fundamentals. Personal values and skills have more importance for the private sector than for the public sector.

Despite the apparently clear structure of the course programs (i.e., Learning outcomes; contents; methodology; evaluation criteria; and bibliography), it was quite often identified relevant data placed according to a different and not clear criteria. This fact required a permanent overlook to all categories instead of focusing the one being analyzed (e.g., at document 23, only at the topic evaluation was mentioned creativity as a requirement for all the activities "*Depth and creativity in applying knowledge*").

Were identified LOs focused on teaching rather than learning, such as presented in doc. 11: "*Sensitization of students to the generality of the design process, as a synthesis operated by drawing in the conception and production of artifacts*", from which we deduce the LO "*recognizing the generality of the design process as a synthesis operated by drawing in the design and production of artifacts*". The same case is presented in doc. 17 for the LO: "*Promoting Elementary Education in Design's Elementary Principles and Techniques*".

Often were found LOs apparently very ambitious and eventually, not realistic, for novices Design students, such as the goal "*to create a product to meet a specific need*". If compared to a medicine study program, for example, it would be expected that by the end of the first-year, the students were able to prescribe a treatment for a patient. Cases like this call the attention to possible misunderstandings of the correct use of LOs in a course program, which more likely addresses the all the first cycle study plan.

6.1 Future study

Some conclusions can be drawn relating future work based on this first attempt to create a 3D matrix of LOs used in the Portuguese Basic Design course programs. It should:

- 1 Focus the interconnections between contents and levels of knowledge, thus clarifying which type of content requires which kind of knowledge and consequently, study possible successful combinations;
- 2 Detail each content major topic (i.e., design fundamentals; communication; project; methodology; means and techniques; contexts (historical; economic; social; cultural)) in all the sub-categories identified and relate them with the Design study program types;
- 3 Complement the analyse to the Basic Design by addressing the other topics present at the course programs, such as contents, methodologies, evaluation and bibliography;
- 4 Revise and improve the process due a possible overlap of LOs classification according *general/specific dimension and personal values and skills in contents dimension*.

In the Portuguese Design study programs scenario, Basic Design course programs affirm its propaedeutic nature, as stated in the expectations to "*abandon preconceived ideas and simulate a new look at objects*", as mentions doc. 36. The aspect of training intuition and the cultivation of self-knowledge in students [9] is also present, in some manner, as verified in the expression at doc. 42, "*The discipline of Color Studies takes place in a pedagogical project where the singularities and abilities of students are developed*".

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REFERENCES

- [1] A. Neves, D. Dias, and E. Duarte, 'As Basic Design promotes the design learning: Featuring the Portuguese Higher Education setting', in *ICERI2018 Proceedings*, 2018, pp. 7663–7671.
- [2] A. G. Neves, E. Duarte, and D. Dias, 'Basic Design at IADE: Drawing the line', in *Design Doctoral Conference'18: TRANSgression. Proceedings of the DDC 5th Conference*, Universidade Europeia, IADE, Lisboa, 2018, pp. 137–144.
- [3] C. Cetinkaya, 'Basic Design Education Parameters in Turkey', in *Humanitas International Journal of Social Sciences*, Central and Eastern European Online Library, 2014, pp. 31–46.
- [4] C. Boucharenc, 'Research on Basic Design Education: An International Survey', *Int. J. Technol. Des. Educ.*, vol. 16, no. 1, pp. 1–30, Jan. 2006.
- [5] C. G. Boucharenc, 'Research on Basic Design Education: An International Survey', *Int. J. Technol. Des. Educ.*, vol. 16, no. 1, pp. 1–30, Jan. 2006.
- [6] D. Akbulut and H. Kesdi, 'On Context, Concepts and Research: An Approach in Basic Design', *Des. J.*, vol. 20, no. sup1, pp. S1197–S1211, Jul. 2017.
- [7] G. Bonsiepe, *Design como Prática de Projeto*. Brasil, S. Paulo: Edgard Blucher, 2012.
- [8] A. Cross, 'The educational background to the Bauhaus', *Des. Stud.*, vol. 4, no. 1, pp. 43–52, 1983.
- [9] J. Itten, *Design and Form: Basic Course at the Bauhaus*, Revised edition edition. London, England; New York: Titles Supplied by John Wiley & Sons Australia, 1975.
- [10] L. Moholy-Nagy, *The New Vision and Abstract of an Artist*, 1928 Fourth revised Edition 1947 edition. George Wittenborn Inc, 1947.
- [11] A. Marcolli, *Teoria del Campo - corso di educazione alla visione*, 1998th, 17^aed ed. Milano: Sansoni Editore, 1971.
- [12] A. Marcolli, *Teoria del Campo 2 - corso di metodologia dalla visione*, 1991st, 3^a ed. ed. Itália, Firenze: Sansoni Editore, 1978.
- [13] A. S. da Silva, 'Modos de aprender', in *Daciano da Costa Designer*, Fundação Calouste Gulbenkian., Lisboa, 2001, pp. 12–17.
- [14] V. Almeida, 'O Design em Portugal, um Tempo e um Modo. A institucionalização do Design Português entre 1959 e 1974', doutoramento, Fac. de Belas Artes, Univ. de Lisboa, Lisboa, 2009.
- [15] M. H. Souto, *História do Design em Portugal I*, Edições IADE. Lisboa, Portugal: 2009.
- [16] D. da Costa, 'Curriculum Vitae'. 2001.
- [17] A. Gomes, 'Design-A construção contínua de competências', Doutoramento, Universidade do Minho - Escola de Engenharia, 2009.
- [18] D. Dias, 'Learning Outcomes in European Higher Education', *Encyclopedia of International Higher Education Systems and Institutions*. Springer Science+Business Media Dordrecht, 2018.
- [19] J. González and R. Wagenaar, Eds., *Tuning Educational Structures in Europe. Universities contribution to the Bologna Process. An introduction*, 2^a. Bilbao: Publicaciones de la Universidad de Deusto, 2008.
- [20] J. Biggs and C. Tang, *Teaching For Quality Learning At University*, Ed: 4. Open Univ. Press, 2011.
- [21] J. Biggs, 'Aligning Teaching and Assessment to Curriculum Objectives', in *Aligning Teaching and Assessment to Curriculum Objectives*, Aveiro, Portugal, 2003.
- [22] M. B. Gregerson, H. T. Snyder, and J. C. Kaufman, Eds., *Teaching Creatively and Teaching Creativity*. New York: Springer-Verlag, 2013.

TRAÇANDO O PERCURSO DO DESIGN BÁSICO NO IADE***DRAWING THE PATH OF BASIC DESIGN AT IADE*****Ana Neves¹, M.Sc.**
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Educação em Design, em Portugal; Design Básico; Realidade Virtual

Este estudo, enquadrado numa investigação que tem como objetivo desenvolver ferramentas tecnológicas inovadoras para o ensino do Design, incide no mapeamento do Design Básico no Ensino Superior português. Para o efeito, analisamos a sua presença e linha evolutiva, num instituto pioneiro do ensino do Design em Portugal, o IADE.

Design education in Portugal; Basic Design; Virtual Reality

Framed on a research that aims the creation of new technologic tools for innovative design education, this study focuses the mapping of Basic Design in the Portuguese Higher Education scenario. It's presence is analysed in IADE, a Portuguese pioneering Design institute, as well and drawn it's evolutionary line.

1. Introdução

1969 em Portugal, cinquenta anos após a criação da Bauhaus School of Design e do emblemático Basic Design Course, o Instituto de Arte e Decoração – IADE encetou o seu percurso pioneiro na educação em design. Perfaz que o corrente ano de 1919 assinala simultaneamente o primeiro centenário da Bauhaus e meio século de existência do IADE.

Ao longo de um século de atualizações do ensino do design, também os fundamentos inicialmente formulados para a introdução dos estudantes neste domínio de estudos, que constituem o Design Básico, foram questionados e revistos. Presentemente, a revisão daqueles fundamentos é também motivada pela inevitabilidade da integração de novas tecnologias digitais no processo de ensino-aprendizagem. Solicitado por este desafio, o IADE acolhe atualmente uma investigação que aborda o impacto da Realidade Virtual (RV) nas experiências pedagógicas dos estudantes de design do 1º ano.

Neste sentido, o estudo aqui apresentado integra uma investigação mais alargada que tem como

objetivo o desenvolvimento de ferramentas

tecnológicas que contribuam para a inovação no ensino do Design.

Este estudo revela uma análise diacrónica realizada aos programas disponibilizados dos cursos de design do IADE, onde oportunamente conduzimos a nossa investigação. Para tal, foram recolhidos e analisados documentos oficiais disponíveis nos serviços académicos e biblioteca do IADE (e.g. estatutos, regulamentos, programas dos cursos, propostas de constituição de cursos e Fichas de Unidades Curriculares - FUCs).

Ao abordar diacronicamente o Design Básico no IADE, complementamos uma análise sincrónica realizada aos cursos de Design em Portugal (NEVES; DIAS; DUARTE, 2018) confirmando, ou, pelo contrário, contrariando a ideia ali avançada de que o Design Básico é uma presença no Ensino Superior, em Portugal. Simultaneamente, é confirmada a ideia adiantada por Neves e Duarte (NEVES; DUARTE, 2015) de que as atuais UCs Laboratório de Design 2D e Laboratório de Design 3D constituem um prolongamento e atualização do

Design Básico.

Ambas as análises, sincrônica e diacrônica, concorrerão para consolidar as fases posteriores da investigação, relacionada com a criação da ferramenta baseada na RV.

1.1. O Design Básico nas escolas clássicas de Design

A partir da Bauhaus School of Design (1919-1933), a educação em design tem vindo a consolidar a sua presença em todo o mundo. O *preliminary*, também designado basic course (curso básico), mais largamente difundido como Basic Design, é considerado um dos principais pilares da Bauhaus (BONSIEPE, 2012) e na opinião de Cross (CROSS, 1983), a mais importante inovação educativa daquela escola. O Basic Design foi criado por Johannes Itten (1888-1967) como um curso semestral que visava a libertação e fortalecimento da imaginação e criatividade dos estudantes de 1º ano do curso de design (ITTEN, 1975). O foco no desenvolvimento da criatividade e originalidade de cada aluno era conseguido pela aplicação prática da teoria dos contrastes polares, assim como pelos exercícios de relaxamento e concentração. Estes faziam parte de uma metodologia para treinar a intuição e cultivar o auto-conhecimento, pois “*o olhar externo da investigação científica e da tecnologia deve ser equilibrado pela auto-reflexão e forças espirituais*”¹ (ITTEN, 1975, p. 9). A influência da escola de pensamento de Dewey, assim como de Floerbel e Montessori nas experiências pedagógicas de Itten correspondem a um fator de inovação ao nível do Ensino Superior (CROSS, 1983).

László Moholy-Nagy (1895-1946) desenvolveu um dos modelos subsequentes do Design Básico, na New Bauhaus de Chicago, em 1937. Manteve a estrutura geral do curso da Bauhaus para formar os futuros designers como integradores (de sistemas). (MOHOLY-NAGY, 1947). O *preliminary* visou formar a capacidade de expressão a partir dos elementos do design (i.e., linha, forma, cor, espaço, movimento, textura e volume) em vários meios/suportes, começando com os tangíveis, a 2D e depois, a 3D (e.g. caneta, lápis, papel, barro e madeira); e seguidamente, os intangíveis (e.g., luz, espaço e som). Estas explorações promoviam a

inteligência visual permitindo a compreensão e consequente capacidade de transformação das relações invisíveis entre os elementos do sistema em toda a sua complexidade (FINDELI, 2001, p. 14). Na Ulm School of Design (1953-1968), a ciência e tecnologia foram reforçados no modelo geral do curso de design, deixando menos espaço para a exploração artística. Neste sentido, a subjetividade inerente à criação das formas foi substituída pela síntese formal com coerência.

Em Itália, a influência do diretor da Ulm School of Design, Tomás Maldonado (1922-2018), no ensino do design, predominou sobre a proposta teórica, ou “*pedagogia projetual*”², de Attilio Marcolli (1930-2010) (1971, p. 3). Nos dois volumes que constituem a sua obra *Teoria del Campo* (MARCOLLI, 1971, 1978), a linguagem menos acessível e um nível elevado de abstração são razões prováveis para o reduzido impacto do seu contributo (FEDERLE, 2009, p. 22). *Teoria del Campo* consiste num curso propedêutico que visa o desenvolvimento da percepção visual através de 4 campos/espacos sucessivos: geométrico-intuitivo; gestáltico; topológico; e fenomenológico. Cada campo é abordado nas suas 4 vertentes: estrutura; composição de objetos; interação campo-objeto; e finalmente, tensão e movimento. A aquisição de tal sistema perceptivo é advém da prática da geometria transformacional envolvida em cada campo, respetivamente: euclideana; afim e projetiva; topológica; e teoria dos conjuntos.

A intensidade e consistência dos exercícios exploratórios e abstratos, é absolutamente essencial para uma aprendizagem efetiva, na perspectiva de Marcolli e também de Munari (MARCOLLI, 1971; MUNARI, 1998). Segundo Munari (1907-1998), para uma aprendizagem efetiva é importante aprofundar todas as áreas, mesmo que aparentemente irrelevantes para os jovens entusiasmados que preferem fazer projetos imediatamente (MUNARI, 1998).

1.2. O Design Básico, hoje

O Design Básico encontra-se internacionalmente implementado e adaptado aos mais variados contextos, (CETINKAYA, 2014). O Design Básico corresponde a uma abordagem pedagógica específica que aborda o modo como os fundamentos

¹ Traduzido pelas autoras.

² Traduzido pelas autoras.

do Design são ensinados e aprendidos, geralmente, pelos estudantes de 1º do Ensino Superior. É conhecido por adotar uma metodologia que favorece, pela prática, a compreensão holística dos fenômenos, a criatividade, experimentação e o desenvolvimento pessoal através da composição dos elementos visuais (i.e., forma, cor, textura, luz e ritmo). Alguns debates no princípio do século incentivaram o renascimento do Design Básico, que se estende a algumas abordagens pedagógicas atuais (BOUCHARENC, 2006). Para efeitos deste estudo, Design Básico é tomado como uma Unidade Curricular.

1.3. A utilização da RV: O contexto pedagógico

RV pode ser considerado um ambiente artificial 3-D onde fenômenos irreais se podem experienciar com a mesma intensidade daqueles outrora exclusivos da vida real. Tal envolvimento é responsável pela sensação de interação intuitiva e em tempo real, com os objetos ali representados. RV distingue-se de outros sistemas que utilizam os Envolvimentos Virtuais (VEs) e caracteriza-se, de acordo com o Triângulo de RV (BURDEA; COIFFET, 2003) por promover a interação, imersão e imaginação, resultando em diferentes níveis de presença. A interação corresponde ao grau de resposta do mundo virtual e de tudo nele contido, em tempo real, às ações do utilizador, podendo desencadear comportamentos realistas ou irrealistas. Imersão tem que ver com o maior ou menor nível de isolamento do mundo real que o sistema oferece. Imaginação é uma variável que depende exclusivamente do participante e da sua vontade de se deixar “enganar”. Estes fatores, juntamente com o grau de intrusão e desconforto causado pela utilização dos aparelhos (e.g. náuseas, fadiga ocular, proficiência com as técnicas de navegação) resultará num variável grau de presença, que se pretende grande. Presença pode ser definida como uma sensação de estar efetivamente presente num mundo virtual, indicando perda de consciência que o corpo permanece fisicamente no mundo real. Quando comparados com outros sistemas que utilizam EVs, os sistemas de RV permitem a avaliação de aspectos da interação com o mundo mais avançados, como o comportamento ou emoções, com boa validade ecológica (e.g., REBELO et al., 2011).

A tecnologia de RV é atualmente utilizada num quadro alargado de aplicações, como jogos, filmes e simulações cujo propósito principal é a formação, treino, educação, trabalho colaborativo, terapia e

aprendizagem (LANYI, 2012). Esta tecnologia permite a geração de fenômenos e experiências alternativas à realidade, possibilitando algumas das experiências pedagógicas mais inovadoras da atualidade (SCHANK, 2011). Contudo, muito do seu potencial está ainda por desvelar (JONES, 2013).

A RV está a tornar-se cada vez mais importante para a educação, facilitando a aprendizagem de conceitos abstratos, a observação de fenômenos a diferentes escalas, e a participação em eventos anteriormente difíceis de aceder devido ao perigo envolvido, aos custos ou até à distância (ABDELAZIZ; RIAD; SENOUSY, 2014, 2014).

A eficácia da formação baseada na tecnologia RV (i.e., jogos, simulações e mundos virtuais) tem sido destacada pela melhoria de resultados face aos objetivos de aprendizagem estabelecidos (MERCHANT et al., 2014). Tal reforça a ideia já conhecida de que os ambientes de aprendizagem baseados em RV impactam positivamente nos domínios cognitivo e afetivo dos estudantes (LEE, 2011). A utilização dos Ambientes Virtuais 3D em experiências de ensino-aprendizagem conduziu a resultados positivos, tendo-se verificado a melhoria da área da representação espacial; um aumento de oportunidades para aprender com base na experiência; o incremento da motivação/interação; a melhoria do contexto de aprendizagem, de modo geral; e o enriquecimento de aprendizagem colaborativa, comparativamente com alternativas 2D (DALGARN; LEE, 2010). Na educação, a RV não só permite a observação a partir de múltiplas perspetivas, o que encoraja diversos modos de pensar, (LEE, 2011, p. 2), como também pode ser utilizada para promover a transferência da aprendizagem (BOSSARD et al., 2008).

Um estudo exploratório intitulado Virtual Reality for Kids interested in Design Studies (VR-KiDS) permitiu avaliar as competências relacionadas com design, em crianças com entre os 11 e os 16 anos de idade, antes e depois da realização de uma atividade que recorria à Realidade Virtual (D'SOUZA; YOON; ISLAM, 2011). Os resultados evidenciaram que a utilização da interface RV aumentou consideravelmente as competências: lógica; cinestésica; e naturalista. Por outro lado, a experiência afetou negativamente as competências: verbal; e intrapessoal. Por fim, a mesma revelou que as competências espaciais e interpessoais não foram

afetadas. Os autores também verificaram que a interface baseada na RV demonstrou maior utilidade para os estudantes que tinham apresentado piores resultados (D'SOUZA; YOON; ISLAM, 2011).

No que se refere ao Design Básico, a investigação demonstra que continua a ser essencial para os estudantes de design o desenvolvimento de competências perceptivas e motoras, como a modelação manual e manipulação dos materiais, apesar dos avanços tecnológicos e das ferramentas computacionais de apoio ao design já tão comumente utilizadas (BOUCHARENC, 2006, p. 18). Sorby (1999) destaca, a este respeito, o benefício da articulação manual-visual para a visualização espacial, uma competência essencial para os designers, que os sistemas de RV podem amplificar (SIK LÁNYI; LÁNYI; TILINGER, 2003, p. 293).

O Design Básico enfrenta a anunciada inevitabilidade da presença da RV no futuro da educação em design (COLUCCI, 2011). A favor desta integração, a investigação deve evidenciar as qualidades da parceria entre a RV e o Design Básico (NEVES; DUARTE, 2015). Somente então a RV poderá revelar-se um meio adequado de expressão (inovação em termos de conteúdo) e um apoio para as experiências de ensino-aprendizagem (inovação ao nível pedagógico).

2. A educação em Design, em Portugal

A primeira experiência pedagógica na área do Design aconteceu em Portugal no decorrer da década de 1960, apesar da palavra "Design" só se ter tornado oficial em 1971, durante a I Exposição de Design Português (SILVA, 2001). Antes disso, a Escola de Artes Decorativas António Arroio – EADAA, contribuiu grandemente, nas décadas de 40 e 50, para a transformação do ensino artístico

português (SOUTO, 2009) e, consequentemente, para a pedagogia do design. Lino António (1898-1974), Frederico George (1915-1994) e Daciano da Costa (1930-2015) abriram o caminho para que tal fosse possível, juntamente com outros professores da EADAA, deixando para trás o ensino tradicional académico de cariz beaux-artiano. Neste sentido, aspetos do movimento *Arts and Crafts* filtrados pelo legado da Bauhaus foram introduzidos no sistema educativo português (ALMEIDA, 2009; SOUTO, 2009).

Duas experiências pedagógicas marcaram a origem da educação em design no país, ainda na sua fase não-formal³: em 1965 teve início o Curso de Formação Artística, na Sociedade Nacional de Belas Artes - S.N.B.A.; e em 1969, o Curso de Decoração de Interiores, no Instituto de Arte e Decoração - IADE (ALMEIDA, 2009; SOUTO, 2009).

Outros tipos de experiências de ensino-aprendizagem na área do Design foram as promovidas pelo Instituto Nacional de Investigação Industrial – INII, uma instituição criada para o desenvolvimento e modernização da indústria portuguesa. INII visava incluir o design através de algumas ações do Núcleo de Arte e Arquitectura Industrial: cursos profissionais de design de curta duração; I Quinzena de Estética Industrial; e em simultâneo, a Exposição Internacional de Design Industrial. Estas atividades de aprendizagem não-formal promoviam o processo de autoaprendizagem e coexistiram em complementaridade com o modelo, na altura ainda dominante, de aprendizagem informal do design.

Os cursos de design criados, primeiro num contexto particular, pelo Instituto de Arte e Decoração - IADE, em 1969, e subsequentemente no ensino público, pela Escola Superior de Belas-Artes de Lisboa - ESBAL, em 1974, obtiveram certificação

³ Salientado por Victor de Almeida em *O Design em Portugal, um Tempo e um Modo. A institucionalização do Design Português entre 1959 e 1974* (tese de doutoramento), a vertente educacional da institucionalização do design em Portugal, no período compreendido entre 1959 e 1974, deu-se de acordo com três modos: aprendizagem informal, aprendizagem não-formal e educação formal. A informalidade marcou os anos entre 1959 e 1964, de uma aprendizagem orientada principalmente nos ateliers. Na "fase informal dos ateliers" aprendia-se em contexto de trabalho, e numa estreita colaboração discípulo/mestre. Um exemplo

icónico desta figura de professor informal foi Frederico George, em cujo atelier se formaram muitos dos primeiros designers portugueses, desde Daciano da Costa a António Sena da Silva. Seguiu-se uma segunda fase "não-formal dos cursos de formação", entre 1965 e 1974. Esta caracterizou-se por ser uma atividade educativa organizada e sistematizada desenvolvida fora dos ateliers e corporações, como os cursos livres para especialização profissional, workshops, seminários e sessões de formação. Finalmente, a educação formal em design passou a fazer-se com a presença em cursos ministrados em instituições de ensino com certificação pública.

por parte do Ministério da Educação, nas décadas de 70 e 80, respetivamente. O reconhecimento oficial do Curso de Design de Interiores e Equipamento Geral, da Escola Internacional de Decoradores, Artistas Gráficos e Designers – IADE, aconteceu 10 anos depois da fundação do instituto, em 1979 (“Resolução nº 171/79 da Presidência do Conselho de Ministros – Gabinete do Primeiro-Ministro. Diário da República 127/1979, Série I de 1979-06-02”, [s.d.]). No caso do curso de Design da Escola Superior de Belas-Artes - ESBAL, deu-se somente em 1983 (ALMEIDA, 2009). Este foi o início da educação formal em Design, em Portugal.

2.1. O ponto de partida do Design Básico

A primeira referência ao Design Básico ministrado em contexto nacional refere-se à experiência pedagógica inédita promovida pelo designer e, na altura, também professor na EADAA, Daciano da Costa. Entre 1962 e 1964 conduziu, em atelier próprio, um curso privado em Design Básico (COSTA, 2001). Neste contexto, os problemas de design que ali surgiam eram analisados de acordo com uma estrutura Bauhausiana: a origem da forma baseava-se numa didática experimental informada pela teoria da forma e da cor, de Johannes Itten, e complementada pelas versões de Laszlo Moholy-Nagy e de Josef Albers (COSTA, 2001).

3. IADE: O pioneiro na educação em Design

1969 assinala a fundação do Instituto de Arte e Decoração – IADE, frequentemente considerado o pioneiro do ensino em design, em Portugal. De acordo com Almeida (ALMEIDA, 2009), o IADE teve um grande contributo na disseminação do Design, abrindo o debate em torno do conceito e ministrando cursos e seminários fora dos ateliers e ambientes corporativos.

O IADE foi fundado por António Quadros (1923-1993), um poeta, filósofo, escritor, professor e figura incontornável da cultura portuguesa do séc. XX. Lima de Freitas (1927-1998), pintor e também ele, vulto de relevo no panorama cultural do país, foi o primeiro diretor do IADE, cargo que desempenhou a convite de António Quadros, até 1972. No ano seguinte António Quadros veio a assumir a direção do instituto, por 20, até 1993, data do seu falecimento. Nesta data, António Roquette Ferro (b. 1952) substituiu o seu pai até 2008. Nos seis

anos seguintes, Carlos Duarte (b. 1962) teve a função directiva do IADE, até se tornar, entre 2014 and 2016, o primeiro reitor do IADE University Institute.

O programa curricular do curso de Decoração de Interiores do IADE, à data da sua fundação, surge numa ficha de estudante no ano letivo 1969/1970. Como verificado na Figura 1 o curso começou por lecionar as seguintes Unidades Curriculares: Desenho I; Desenho de Projecções; História da Arte Universal; e Tecnologia e Materiais. Nesta data, não há qualquer referência ao Design Básico. Também a expressão “Design” é presente no documento.

Figura 1 (frente): Ficha de estudante com o programa curricular do curso de Decoração do IADE; ano letivo 1969-70.

Figura 1 (costas): Ficha de estudante com o programa curricular do curso de Decoração do IADE; ano letivo 1969-70.

A criação do IADE visou o ensino de cursos de arte e decoração, e, de modo geral, o fomento do estudo e difusão do conhecimento das artes e das ciências (Diário do Governo: III série, Nº 235, 1969). O Curso de Decoração de Interiores, de 3 anos, iniciou-se com os professores Pintores Manuel Lapa, Lima de Freitas, Rafael Calado, Eduardo Nery

e Manuel Costa Cabral. Os arquitetos, Francisco Keil do Amaral, Manuel Costa Martins e Júlio Gil, a escultora Graça Costa Cabral, o designer John David Bear e António Quadros também foram professores no instituto, entre muitos outros (IADE – INSTITUTO DE ARTES VISUAIS, DESIGN E MARKETING, 1989).

Com a chegada do designer John David Bear ao corpo docente do IADE, em 1970, alteram-se as orientações pedagógicas “*substituindo-se então o conceito primitivo de decoração pelo de design, muito mais amplo, mais atual e sem dúvida mais adequado às linhas de futuro que já se anteviam para a indústria e para a economia portuguesas.*” (IADE – INSTITUTO DE ARTES VISUAIS, DESIGN E MARKETING, 1989, p. 17).

A integração progressiva do novo conceito “Design” deveu-se a David Bear, mas igualmente, ao designer francês, Claude Ternet (do CREE – Centre de Recherches d’Esthétique Industrielle), e às relações com a Escola Politécnica de Design, de Milão. A colaboração do diretor da escola italiana, Prof. Di Salvatori, possibilitou que a partir de 1973-74 se ministrassem no IADE seminários sobre Design. Bruno Munari e Attilio Marcolli orientaram seminários no IADE nos anos 70 e 80, contribuindo para as opções pedagógicas do instituto. Em 1974 e 1977, Bruno Munari orientou dois seminários sobre Design Industrial, tendo nesta última data, analisado os programas do IADE e trabalhado com os professores do curso, daí “*resultando melhorias flagrantes no currículo, seu conteúdo e seus métodos.*” (IADE – INSTITUTO DE ARTES VISUAIS, DESIGN E MARKETING, 1989, p. 18).

No decorrer da 2ª Exposição de Design Português, realizada em 1973, promovida pelo Instituto Nacional de Investigação Industrial - INII, António Quadros e Nuno Portas participaram num debate sobre o design de interiores e o seu ensino (QUADROS, 1993). No catálogo da exposição, António Quadros⁴ (1973) refere-se ao Curso de Decoração de Interiores do IADE. Face ao incremento da importância do design para o desenvolvimento da indústria portuguesa, nomeadamente, nas artes aplicadas e estética industrial, e a “*dificuldade de obter designers*

portugueses para o ensino” (QUADROS, 1973, p. 230) António Quadros justifica a recorrência do IADE a profissionais e professores estrangeiros para a formação de novos designers. Afirma que “No IADE, o *Design é ensinado no curso de Decoração de Interiores, da Escola Internacional de Decoradores (2º e 3º ano), em estreita conjugação com as disciplinas de Projetos e Desenho; e ainda no curso de Design Industrial, da Escola Internacional de Artes Visuais*” (QUADROS, 1973, p. 230). Por falta de acesso a outra documentação que se refira ao programa do curso naquele ano, o catálogo da 2ª Exposição de Design Português é a única fonte reveladora dos tópicos das disciplinas Design I e Design II, respetivamente, do 2º e 3º anos do curso. O mesmo documento é, no entanto, omissivo relativamente ao programa do 1º ano do curso.

4. O Design Básico, no IADE

O primeiro programa curricular do IADE disponibilizado para este estudo, que menciona Design Básico, refere-se ao ano académico de 1979-80, do Curso de Design de Interiores e de Equipamento Geral, como apresentado na Figura 2. Os tópicos desenvolvidos naquela disciplina anual constam na Tabela 1 para uma maior clareza.

Se bem que anteriormente aquela data se desconheça o programa do 1º ano dos cursos ministrados no IADE, António Quadros (1973) referiu-se brevemente à formação anterior ao 2º ano do Curso de Decoração de Interiores, da Escola Internacional de Decoradores, ao mencionar que o ensino do design, iniciado no IADE em 1970, surge “*quando os alunos têm já uma preparação mínima de Projectos e Desenho*” (1973, p. 230). No entanto, podem ser identificados em Design I, tópicos posteriormente abordados em Design Básico: (i) Introdução ao tridimensionalismo. Formas simples: planificação e construção, cor. Agrupamento destas formas numa sequência lógica; e (ii) Ligações de peças de estrutura, a todas as escalas (QUADROS, 1973, p. 230).

Design Básico				
1	Ponto.	Linha.	Superfície.	Forma aberta. Forma fechada

⁴ A autoria deste texto originalmente publicado no Catálogo da 2ª Exposição de Design Português, em 1973, é somente divulgada na revista Cadernos de Design, nº 5, onde o mesmo é transcrito com o título: “António

Quadros (1923-1993)”. A revista é publicada no ano do falecimento de António Quadros, 1993, a mesma data em que fez 70 anos na direção do instituto que fundou e 70, de nascimento.

2	Formas geométricas elementares. Divisão interna de polígonos regulares e sua transformação.
3	Transformação progressiva de superfícies regulares. Recreação de formas geométricas simples. Organização sistemática de superfícies.
4	Noções elementares de ritmo e padrão.
5	Formas tridimensionais. Sólidos geométricos elementares. Forma, função.
6	Planificação e conhecimento de espaço interno. Divisão interior de sólidos. Noção de estrutura. Organização de estruturas geométricas. Representação gráfica. Interpretação e transformação dos resultados obtidos.
7	Métodos de representação gráfica; Desenho perspectivo e desenho interpretativo.
8	Cor. Complementaridade da cor. Simultaneidade. Saturação. Aspectos subjetivos e psicológicos da cor. Exercícios de aplicação prática.
9	Textura. Noção e expressão de texturas naturais. Reconhecimento, recolha e representação.
10	Texturas artificiais. Organização de superfícies para criação ou recreação de texturas.
11	Análise textural de materiais de construção e revestimento. Textura gráfica.
12	Representação gráfica textural. Textura-cor. Exercícios de criação ambiental."

Quadro 1: Tópicos da disciplina Design Básico, 1979.

IV DESIGN BÁSICO - 5ª SEMANA	
1-	Ponto. Linha. Superfície. Formas abertas. Formas fechadas.
2-	Formas geométricas elementares. Divisão interna de polígonos regulares e sua transformação.
3-	Transformação progressiva de superfícies regulares. Recreação de formas geométricas simples. Organização sistemática de superfícies.
4-	Noções elementares de ritmo e padrão.
5-	Formas tridimensionais. Sólidos geométricos elementares. Forma, função.
6-	Planificação e conhecimento de espaço interno. Divisão interior de sólidos. Noção de estrutura. Organização de estruturas geométricas. Representação gráfica. Interpretação e transformação dos resultados obtidos.
7-	Métodos de representação gráfica. Desenho objetivo; Desenho perspectivo e desenho interpretativo.
8-	Cor. Complementaridade da cor. Simultaneidade. Saturação. Aspectos subjetivos e psicológicos da cor. Exercícios de aplicação prática.
9-	Textura. Noção e expressão de texturas naturais. Reconhecimento, recolha e representação.
10-	Texturas artificiais. Organização de superfícies para criação ou recreação de texturas.
11-	Análise textural de materiais de construção e revestimento. Textura gráfica.
12-	Representação gráfica textural. Textura-cor. Exercícios de criação ambiental.

Figura 2: Programa de Design Básico, 1979.

Durante os anos 80, o currículo do Curso de Design de Interiores e de Equipamento Geral estabeleceu, para o 1º ano, o seguinte conjunto de disciplinas: Design Básico; Introdução ao Design; Problemas da Estética Industrial; Psicologia da Comunicação Visual; Estética e História de Arte I; Desenho; e Desenho Técnico (IADE - ESCOLA INTERNACIONAL DE DECORADORES, ARTISTAS GRÁFICOS E DESIGNERS, anos 80 (nota)). Refere ainda o Design Básico como uma das disciplinas nucleares do curso, a par de Desenho Técnico: Desenho Experimental; Projetos de Interiores I e II; Design de Equipamento I e II, e Design Gráfico I e II. No entanto, o documento não inclui os programas das disciplinas.

Em 1982 são compilados: o conceito e objetivos; o currículum; e os programas do Curso de Design de Interiores e Equipamento Geral (IADE - ESCOLA INTERNACIONAL DE DECORADORES, ARTISTAS GRÁFICOS E DESIGNERS, 1982). O programa da disciplina Design Básico repete os tópicos do anterior, de 1979. Se nesta vertente não há alterações, novos aspetos relativos à opção pedagógica do curso são detalhados: os objetivos e estrutura do curso são expressos através do Quadro Orgânico de Necessidades (Figura 3) e Quadro Orgânico de Matérias (Figura 4) (IADE - ESCOLA INTERNACIONAL DE DECORADORES, ARTISTAS GRÁFICOS E DESIGNERS, 1982, p. 4-5). Os 3 anos sucessivos do curso destinavam-se a focar, respetivamente, o apetrechamento básico, a iniciação profissional e a formação profissional dos estudantes. Neste panorama são acentuados aspetos relacionados com a educação do espírito, a formação cultural, a informação científica e tecnológica e a experimentação prática, tal como expressa o Quadro Orgânico de Necessidades (Figura 3).

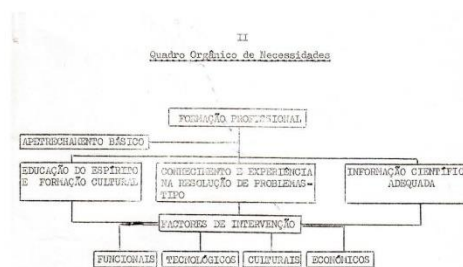


Figura 3: Quadro Orgânico de Necessidades, 1982.

Por conseguinte, o Quadro Orgânico de Matérias vem demonstrar a estrutura curricular para fazer face aos objetivos estabelecidos (Figura 4).

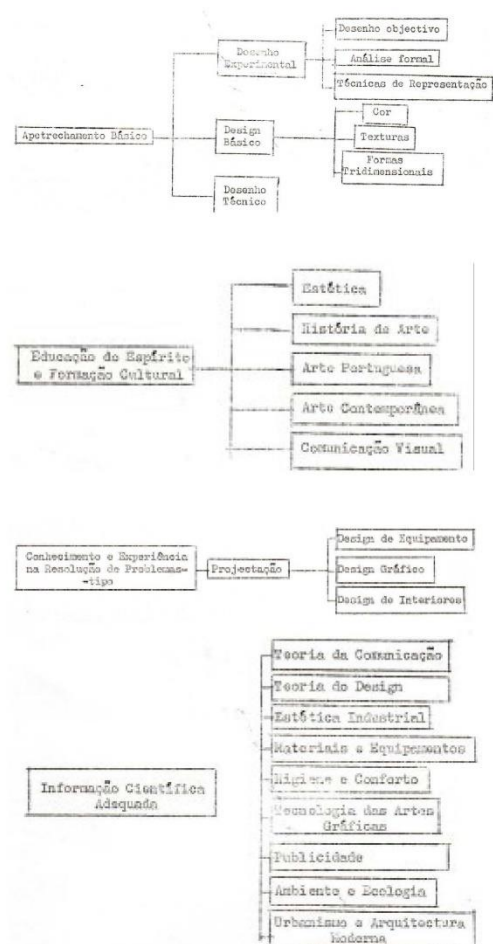


Figura 4: Quadro Orgânico de Matérias, 1982.

Em 1986, os tópicos previamente abordados em Design Básico: Iniciação ao Estudo da Cor e da Textura; Desenho de Letra; e Desenho Experimental I, tornaram-se disciplinas autônomas (IADE - ESCOLA INTERNACIONAL DE DECORADORES, ARTISTAS GRÁFICOS E DESIGNERS, 1986, p. 25) e o Design Básico desapareceu do programa do curso (Figura 5).

Simultaneamente, e em certo modo, contraditório, o mesmo documento refere que o Curso de Design de Moda, iniciado em 1984, adotou algumas disciplinas do curso de Design de Interiores e de Equipamento Geral, como o Design Básico, lecionado pelo Professor Rafael Calado, mas também Desenho Técnico, História da Arte e História do Design (1986, p. 22).

VI - Programas do 1º Ano

- I - Introdução à História do Design
- II - Introdução à Teoria do Design
- III - Desenho Técnico
- IV - Iniciação ao Estudo da Cor e da Textura
- V - Desenho de Letra
- VI - Desenho Experimental I
- VII - Estética e História de Arte I
- VIII - Psicologia da Comunicação Visual
- IX - Geometria Descritiva I
- X - Leitura e Análise da Imagem

Figura 5: Disciplinas lecionadas no 1º ano do curso de Design de Interiores e Equipamento Geral, 1986.

No ano acadêmico 1988/89, a disciplina Design Básico volta a fazer parte do curriculum do curso, assim como no ano letivo seguinte 1989/90. Pode notar-se (Figura 6) que a disciplina Design Básico retoma o anterior modelo, voltando a integrar o conteúdo das 3 disciplinas: Cor; Desenho Experimental; e Letra.

1º ANO - 88/89			
DESIGN BÁSICO	3 x	2,5 + 2,5 + 2,5	
DESENHO TÉCNICO	2 x	2,5 + 2,5	
GEOMETRIA DESCRITIVA	1 x	2,5	
DESENHO DE LETRA	1 x	2	
HISTÓRIA DE ARTE	2 x	1 + 1	
HISTÓRIA TEORIA / DESIGN	1 x	1	
PSICOLOGIA	1 x	1	
TOTAL		21 HORAS	

1º ANO - 89/90			
DESIGN BÁSICO	3 x	2,5 + 2,5 + 2,5	
(COR / DESENHO EXPERIMENTAL / LETRA)			
DESENHO TÉCNICO	2 x	2,5 + 2,5	
GEOMETRIA DESCRITIVA	2 x	2,5 (1+1,5)	

Figura 6: A disciplina Design Básico está presente no programa do 1º ano do curso de Design e Equipamento Geral, nos anos letivos 1988/89 (acima) e 1989/90 (abaixo).

Em 1989 o instituto passa a designar-se IADE -

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LEUI | Laboratório de Ergodesign e Usabilidade de Interfaces

Instituto de Artes Visuais, Design e Marketing, S.A. (“Diário da República 68/1989, 1º Suplemento, Série III”, 1989) orientando-se para “o fomento e ensino das artes, das ciências e das técnicas, nomeadamente através dos cursos de áudio-visuais, design de interiores e equipamento geral, design de moda e marketing e publicidade” (“Diário da República 68/1989, 1º Suplemento, Série III”, 1989, p. 5296-(28)). A autorização do funcionamento do curso superior de Design e do curso superior de Marketing e Publicidade, conferentes do grau de bacharelato (“Portaria n.º 672/90 do Ministério da Educação. Diário da República 187/1990, Série I de 1990-08-14”, [s.d.], p. 90) surge em 1990, para funcionamento no ano letivo de 1990-91.

O curso de Design oferece as opções de especialização Design Visual, Design Industrial e Design de Interiores. De acordo com o plano de estudos de 3 anos, os dois primeiros anos são comuns às três especialidades, sendo o último aquele que apresenta as disciplinas específicas de cada área escolhida. No plano de estudos do curso, o Design Básico consta como disciplina anual, ministrada ao longo do primeiro ano, com uma carga de 5 horas letivas semanais.

Em 1989, os objetivos passaram a constar no programa da disciplina (Figura 7). No ano seguinte, a referência ao método de ensino foi acrescentada e os anteriormente designados “vetores fundamentais”, tornaram-se os “conteúdos programáticos” (Figura 8).

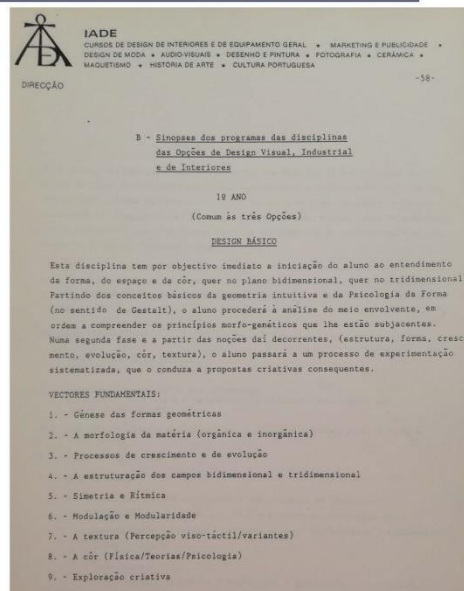


Figura 7: Programa de Design Básico, 1989.

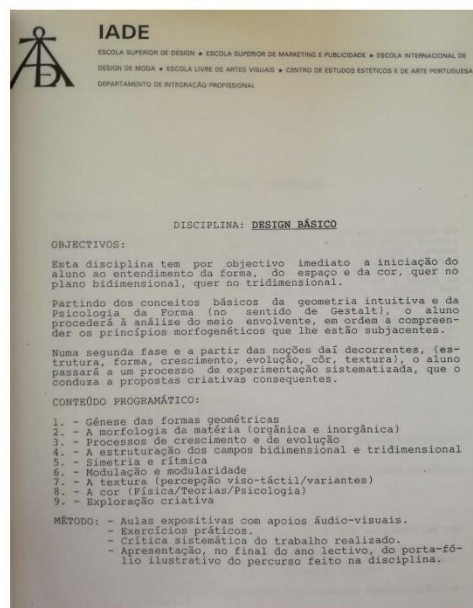


Figura 8: Programa de Design Básico, 1990.

O reconhecimento do grau de licenciatura aos

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diplomas de conclusão do curso superior de Design e do curso superior de Marketing e Publicidade surge em 1993 (Portaria nº 866/93 do Ministério da Educação. Diário da República 216/1993, Série I-B de 1993-09-14", [s.d.], p. 93). São homologados novos planos de estudo de quatro anos com especialização nos dois últimos, nas variantes de Design Visual, Design Industrial e Design de Interiores. Igualmente se mantém o Design Básico como disciplina prática a ser lecionada cinco horas por semana. Após 9 anos, o programa de Design Básico continua ainda a ser utilizado (IADE, 1999).

Em 2003, fruto da implementação do "Processo de Bolonha" no sistema de Educação Superior, algumas alterações ocorreram ao nível do curriculum dos cursos do IADE e inevitavelmente, dos programas das disciplinas (Portaria nº 61/2003 do Ministério da Ciência e do Ensino Superior. Diário da República 13/2003, Série I-B de 2003-01-16, [s.d.]). As disciplinas anuais deram lugar a Unidades Curriculares semestrais. O Design Básico foi substituído pelas UCs Análise Morfológica e Análise Cromática, que, em semestres intercalados, lecionam os conteúdos anteriormente ali abordados, ambas com sete horas letivas semanais atribuídas. Como os próprios nomes indicam, Análise Morfológica (Figura 9) adota os conteúdos de Design Básico relacionados com a gênese e transformação formal; e Análise Cromática (Figura 10) aborda mais detalhadamente a teoria e a prática dos fenómenos cromáticos da composição.

Disciplina: ANÁLISE MORFOLÓGICA			
Regime:	Ano:	Tipo:	Responsável:
Semestral	1º	Técnico-Prática	Designer Carlos Barbosa, Professor Auxiliar Convocado
		Semestral alternada	
Objectivos:		Síntese Programática:	
- Facultar um corpo teórico apresentando os fundamentos para o domínio da linha base do desenvolvimento das faculdades projectuais.		I Análise Bidimensional Criação de traçado estrutural; Transformações reticuladas derivadas das retículas elementares; "Motivo Elementar"; criação do motivo; exploração gráfica; Criação de figuras através das operações de simetria ("motivo elementar"); Definição do princípio de variabilidade; Definição dos critérios de selecção; exploração gráfica da figura; Opção por uma "linha gráfica" - exemplos de diversas aplicações; Exploração gráfica com base na conjugação das selecções anteriores - aplicação em diversos "marcos de referência"	
- Dominar a capacidade de problematizar através da fragmentação de elementos estruturantes do projecto.		II Análise Tridimensional Caracterização de elementos regulares e semi-regulares Uso do "marco de referência"; Políedros regulares e semi-regulares, Criação de marcos; Criação do traçado estrutural; Ligações estruturais; Simplificação estrutural; Flexibilidade da estrutura - semi-ponto de coerência formal; Criação modular; Acoplamento	
- Aprofundar técnicas operativas que explorem o nexo entre a linguagem visual e a linguagem informática estimulando a imaginação e a criatividade.		III Análise Espacial Técnicas de Transição de figura 2D para 3D: uso do "marco de referência" (políedros regulares); uso de cotas de altura, transição livre; técnicas de acoplamento; ligações estruturais diversas e a diferentes escalas; Flexibilidade da estrutura; Simplificação Estrutural	
Metodologia:		Bibliografia Geral:	
I Aulas expositivas de apresentação de exercícios.		Bordaghe, Gui, <i>Teoria e Prática do Design Industrial</i> , Centro Português do Design, Lisboa, 1997	
II Exercícios de resultado controlado, acompanhados pelo docente.		Dormer, Peter, <i>The Art of the Maker - Skill and its Meaning in Art</i> , Craft and Design, Thames and Hudson, London, 1994	
III Trabalho experimental motivador da investigação e pesquisa.		Lewison, Bryan, <i>How Designers Think - the Design Process Demystified</i> , Butterworth - Heinemann, Oxford, 1997	

Figura 9: Separação dos conteúdos do Design Básico: Análise Morfológica, 2002-03.

Disciplina: ANÁLISE CROMÁTICA			
Regime:	Ano:	Tipo:	Responsável:
Semestral	1º	Técnico-Prática	Designer Helena Pereira, Assistente
		Semestral alternada	
Objectivos:		Síntese Programática:	
- Entender a Cor como resultado das leis da Física mas também segundo as leis que regulam a visão das coisas atendendo à Cultura, à Psicodinâmica e à Comunicação.		I. Os Fundamentos da Cor O que é a cor? Psicologia da cor: Como a luz dá cor aos objectos; Factores da percepção: Meios e Técnicas, O olho e o cérebro, Psicologia e Cultura; Cor Natural, Óptica e a Cor Artificial; Teoria da Cor (Autores Fundamentais sobre a cor); Agentes Cromáticos: Matéria aditiva, Matéria subtractiva; Pigmentos e tintas, Visuais e superfícies, A cor na impressão, Fotografia.	
- Dominar uma gramática da cor de modo a entender as variadas sistemas operativos cromáticos.		II. Dimensões da Cor Matiz - Mistura de Matizes: Círculo dos pigmentos, Sistema de Munsell, Círculo da luz, Matizes em composições Valor - O valor da matiz: Discordância, Valor e Clareza Espaciais, Claro-escuro, Profundo e Tenazura, Enfatização e Definição, Contraste e Gradação; O valor nas composições Saturação - Pureza, Complementaridade, Efeito Simultâneo e Controle Cromático	
- Exercitar a capacidade de manipular pigmentos e tints antecipando utilizações plásticas da cor.		III. Atributos da Cor Intensidade Cromática: Primárias, Complementares; Escala de Cores, Pares Falsos, Brilho, Intensidade nas Composições, Equilíbrio, Intensidade e Valor, Efeitos de Profundidade, Proporção; Temperatura da Cor IV. Cor Aplicada Cor e os Princípios do Design - Ritmo, Equilíbrio, Proporção, Escala, Harmonia, A Cor e os Elementos do Design - Espaço: A Ilusão da Transparência, Translucidez, Volume, Dominância, Intermedialidade e Espaço; Linha: Contorno, Legibilidade, Outros tipos de Formação da Linha, A forma e Tridimensionalidade; Texturas: Superfícies Reflectoras; Luz: Tipos de Luz; Interações Cromáticas; Imagens Remanescentes; Contraste Sucessivo; Contraste Simultâneo: Acromático, Cromático, Efeito de Sétio; Mistura Óptica.	
Metodologia:		Bibliografia Geral:	
I Aulas expositivas de apresentação de exercícios.		Fehner, Edith Anderson, <i>Colour</i> , Laurence King Publishing, London, 2001	
II Exercícios de resultado controlado, acompanhados pelo docente.		Gage, John, <i>Colour and Culture</i> , Thames/Hudson, Oxford, 1993.	
III Trabalho experimental motivador da investigação e pesquisa.		Köppen, Harald, <i>Fundamentos de la Teoría de los Colores</i> , Ediciones G. Gili Bunz, Hans-Nelke e Zuppoli, <i>Tratado de Colours</i> , Presses Polytechniques et Universitaires, Romandés. Anheim, Rudolf, <i>Arte e Percepção Visual - Uma Psicologia de Visão Criativa</i> , Livros da Poesia da Arte, Arquitectura e Urbanismo - 6ª Edição, 1991.	

Figura 10: Separação dos conteúdos do Design Básico: Análise Cromática, 2002-03.

A partir do ano letivo 2010-2011, o curso de Licenciatura em Design, da Escola Superior de Design, do IADE – Instituto de Artes Visuais, Design e Marketing, S.A., alterou o plano de estudos do 1º ano ("Despacho nº 9094/2010. Diário da República n.º 102/2010, Série II de 2010-05-26", [s.d.]). Naquele momento, as UCs Design Tridimensional (Figura 11) e Design Bidimensional (Figura 12), vieram substituir Análise Morfológica e Análise Cromática, respetivamente. Entre Análise Morfológica e Design Tridimensional não são notadas quaisquer diferenças nos conteúdos, objetivos e metodologias adotadas, apesar do nome indicar um maior enfoque na tridimensionalidade. Por outro lado, entre Análise Cromática e Design Bidimensional, não só se verifica a inclusão da vertente tipográfica, como os conteúdos relacionados com a teoria da cor passaram a ter menos expressão.

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Licenciatura em Design do curso de licenciatura em design não implicou alterações significativas para o primeiro ano, mantendo-se inalterados os programas das UCs Laboratório de Design 3D e Laboratório de Design 2D.

Conclusões

A UC Design Básico, no IADE esteve integrada de modo consistente no curso de Design, desde 1979 até à separação semestral que ocorreu no ano letivo 2002-03. Ao longo da primeira década de existência do IADE não foram encontrados registros da existência da UC, dado que não consta no currículo do curso à data de 1969-70, (i.e., na ficha de estudante) e destas aqui presentes não se conhecem os programas.

Diferentes designações têm sido encontradas desde 2003, dependendo dos conteúdos: Análise Morfológica adotou o conteúdo de Design Básico que diz respeito aos princípios morfológicos e morfogenéticos; e Análise Cromática adotou os conteúdos relacionados com os fundamentos da cor. Em 2010 aquelas foram substituídas, respetivamente, por Design Tridimensional e Design Bidimensional; e após 2014, até à atualidade, Laboratório de Design 3D e Laboratório de Design 2D.

Ambas as versões de Design Básico, que abordam a forma ou a cor, numa visão complementar, aplicaram métodos de ensino-aprendizagem que recorreram à experimentação. Tal concorre para a ideia de que o Design Básico continuou a sua presença no IADE após 2002-03. Deste modo, a presente estrutura deriva dos estudos morfológicos e cromático incluídos no curriculum do Design Básico, desde 1979, por sua vez, continuando a tradição do legado centenário de Johannes Itten.

Durante os 50 anos de existência do IADE, alguns aspetos devem ser destacados relativamente ao Design Básico:

- A primeira referência à disciplina Design Básico encontra-se no programa da disciplina, no ano académico 1979-80, do Curso de Design de Interiores e de Equipamento Geral.
- Em 1989, o programa da disciplina Design Básico (IADE – INSTITUTO DE ARTES VISUAIS, DESIGN E MARKETING, 1989) inclui o tópico “criatividade” pela primeira

vez, sendo mantida e reforçada a sua presença ao longo dos anos seguintes. Refere concretamente, como objetivo, que os estudantes sejam capazes de realizar “propostas criativas” (1989, p. 58) no culminar de um processo de conhecimento dos fundamentos e experimentação. Aponta ainda como vetor fundamental (conteúdos programáticos), a “exploração criativa” (1989, p. 58).

- Exercícios respiratórios de relaxamento e de concentração não aparecem em nenhuma versão do programa da disciplina Design Básico.
- As atuais UCs Laboratório de Design 3D e Laboratório de Design 2D, herdeiras do Design Básico, utilizam abordagens metodológicas diferentes. Enquanto a primeira incide, como verificado na corrente tradicional do Design Básico, numa vertente exploratória de conceitos abstratos à criação formal 3D, a segunda aproxima-se de uma versão projectual, que visa um produto normalmente associado ao design gráfico onde são aplicadas teorias e elementos cromáticos e tipográficos.
- O tópico “texturas” deixou de ser abordado a partir da separação do Design Básico em UCs semestrais, em 2002-03.
- Desde 1990, o programa de Design Básico adotou o modelo atual (i.e., estruturado de acordo com: objetivos de aprendizagem; conteúdos programáticos; e metodologia).

Considerações finais

Este é o primeiro traço da identidade do IADE relativo a uma das componentes mais importantes do ensino-aprendizagem do design, mais difundido como Design Básico.

Foi identificada a presença da disciplina e simultaneamente, lançado o desafio de aprofundamento da investigação para superar um hiato de informação que durou a primeira década de existência do instituto. Contudo, outros métodos devem ser aplicados, como a recolha de testemunhos de estudantes, professores e funcionários.

António Quadros aponta a indispensabilidade da criatividade dos designers portugueses para acrescentar qualidade, imaginação e invenção, em sintonia com a evolução técnico-científica, com os requisitos da indústria e condicionantes como a empresa, mercado e economia. (IADE – INSTITUTO DE ARTES VISUAIS, DESIGN E MARKETING, 1989, p. 5). Neste sentido se enquadra o requisito “criatividade” nos objetivos da disciplina, desde 1989 até à atualidade. Perante este facto é de salientar que a criatividade foi, em grande parte, o que motivou Johannes Itten, em 1919, para a invenção do curso básico. Tal visão mais alargada da criatividade motor da mudança e transformação social, acentuam a importância de aprofundar o conhecimento em torno do Design Básico, e eventualmente, de o retomar, na atualidade.

Destacamos ainda a necessidade de aprofundar a ideia de que as opções pedagógicas do IADE, para além de terem tido a influência das escolas clássicas de design, frutificaram de/numa cultura e tradição portuguesas. De facto, o impacto da obra das maiores figuras do século XX português na pedagogia do IADE ainda está por fazer. Particularmente, a influência dos valores humanistas e convicções espirituais partilhados por António Quadros e Lima de Freitas. Destacamos o livro que este pintor dedicou aos seus alunos do IADE, *Voz Visível*, (FREITAS, 1971), no qual associa o trabalho artístico ao de um percurso de transformação pessoal, com um discurso rico em analogias (e.g., entre o mundo da imagem e o Hinduísmo, onde a pintura é considerada a alquimia da luz). Tal pode sugerir alguma influência das suas crenças religiosas e espirituais nas suas opções pedagógicas. De facto, conexões semelhantes foram reveladas por Johannes Itten, em *Design and Form* (1975). Apesar dos 50 anos que separam o IADE e a Bauhaus School of Design, os aspetos que partilham, como o referido, merecem alguma atenção.

Igualmente, uma análise mais detalhada aos programas das disciplinas do Design Básico no IADE é recomendada para aferir o desenvolvimento dos tópicos: objetivos de aprendizagem, conteúdos programáticos e metodologia.

A análise diacrónica aqui apresentada revela o percurso do Design Básico no IADE. A sua persistência ao longo de quarenta anos chama a

atenção para a potencialidade de desenvolvimento e inovação desta UC, especialmente, se considerarmos as tecnologias digitais emergentes, particularmente, a RV. Juntamente com os resultados obtidos na análise sincrónica do Design Básico na atualidade dos cursos de design, no Ensino Superior português (NEVES; DIAS; DUARTE, 2018) podemos confirmar a presença do legado pedagógico centenário de Johannes Itten neste contexto.

Apoiada nestes resultados, a fase seguinte da investigação consistirá na criação de um estudo de caso envolvendo a conceção de uma ferramenta baseada na RV e o seu teste empírico, no curso de design do IADE. Para tal, será utilizada uma abordagem de User Centered Design – UCD, e aplicada uma metodologia mista quase-experimental. O potencial da ferramenta será avaliado comparando o desempenho de dois grupos de estudantes. É expectável que a investigação contribua ativamente para promover mais e melhores competências nos estudantes e para aumentar a qualidade do processo de ensino-aprendizagem, em Design Básico. Um estudo piloto foi já realizado por Neves et al. (2016; 2017), que envolveu a criação de uma ferramenta baseada na RV e o seu teste em contexto de ensino-aprendizagem, numa UC lecionada no curso de Design do IADE, com raízes no Design Básico, designada “Laboratório de Design 3D”.

Referências

- ABDELAZIZ, M.; RIAD, A.; SENOUSY, M. B. Challenges and Issues in Building Virtual Reality-Based e-Learning System. *International Journal of e-Education, e-Business, e-Management and e-Learning*, v. 4, n. 4, p. 320–328, 2014.
- ALMEIDA, V. O Design em Portugal, um Tempo e um Modo. A institucionalização do Design Português entre 1959 e 1974. doutoramento—Lisboa: Faculdade de Belas Artes, Universidade de Lisboa, 2009.
- BONSIEPE, G. Design como Prática de Projeto. Brasil, S. Paulo: Edgard Blucher, 2012.
- BOSSARD, C. et al. Transfer of learning in virtual environments: a new challenge? *Virtual Reality*, v. 12, n. 3, p. 151–161, 26 mar. 2008.
- BOUCHARENC, C. G. Research on Basic Design

- Education: An International Survey. *International Journal of Technology and Design Education*, v. 16, n. 1, p. 1–30, 1 jan. 2006.
- BURDEA, G. C.; COIFFET, P. *Virtual Reality Technology*. 2nd edition ed. Hoboken, N.J: Wiley-IEEE Press, 2003.
- CETINKAYA, C. Basic Design Education Parameters in Turkey. In: *Humanitas International Journal of Social Sciences*. [s.l.] Central and Eastern European Online Library, 2014. p. 31–46.
- COLUCCI, K. What role will technology play in the future of design education? In: *Incograde Design Education Manifesto 2011*. [s.l: s.n.]. p. 63–67.
- COSTA, D. DA. *Curriculum Vitae*, 2001.
- CROSS, A. The educational background to the Bauhaus. *Design Studies*, v. 4, n. 1, p. 43–52, 1 jan. 1983.
- DALGARNO, B.; LEE, M. What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology*, v. 41, n. 1, p. 10–32, 2010.
- Despacho nº 2102/2018. *Diário da República* n.º 41/2018, Série II de 2018-02-27, 2018. Available at: <www.dre.pt>. Accessed on 31st May 2018.
- Despacho nº 9094/2010. *Diário da República* n.º 102/2010, Série II de 2010-05-26, [s.d.]. Available at:<www.dre.pt>. Accessed on 31st May 2018.
- Diário da República* 68/1989, 1º Suplemento, Série III, 22 mar. 1989. Available at:<www.dre.pt>. Accessed on 31st May 2018.
- Diário do Governo*: III série, Nº 235 (1969), 7 out. 1969. Available at:<www.dre.pt>. Accessed on 31st May 2018.
- D'SOUZA, N.; YOON, S.-Y.; ISLAM, Z. Understanding design skills of the Generation Y: An exploration through the VR-KiDS project. *Design Studies*, v. 32, n. 2, p. 180–209, mar. 2011.
- FEDERLE, G. *Basic Design La formazione al design nella Scuola secondaria*. Doutoramento-Venezia, Italia: Università Ca' Foscari Venezia, 2009.
- FINDELI, A. Rethinking Design Education for the 21st Century: Theoretical, Methodological, and Ethical Discussion. *Design Issues*, v. 17, n. 1, p. 5–17, 1 jan. 2001.
- FREITAS, L. DE. *Voz Visível*. Lisboa: Ed. Autor, 1971.
- IADE. Programa do Curso Superior de Design. Licenciatura 1999/2000 (documento interno), 2000 1999.
- IADE. Disciplinas do Plano de Estudos da Licenciatura em Design, 2014/15(documento interno), 2014.
- IADE - ESCOLA INTERNACIONAL DE DECORADORES, ARTISTAS GRÁFICOS E DESIGNERS. Regulamento da Escola Internacional de Decoradores, Artistas Gráficos e Designers. Escola Livre de Artes Visuais. Centros de estudos, investigação e documentação. Planos de Estudos, Currículos e regulamentos internos do IADE dos anos 80 (nota) (documento interno), (s.d.).
- IADE - ESCOLA INTERNACIONAL DE DECORADORES, ARTISTAS GRÁFICOS E DESIGNERS. Conceito e objetivos; curriculum; e programas do Curso de Design de Interiores e de Equipamento Geral (documento interno), 1982.
- IADE - ESCOLA INTERNACIONAL DE DECORADORES, ARTISTAS GRÁFICOS E DESIGNERS. Conceito e objetivos; curriculum; e programas do Curso de Design de Interiores e de Equipamento Geral (documento interno), 1986.
- IADE - ESCOLA INTERNACIONAL DE DECORADORES, ARTISTAS GRÁFICOS E DESIGNERS. Programas do Curso de Design de Interiores e de Equipamento Geral dos anos letivos 1988/89 e 1989/90(documento interno), 1989.
- IADE – INSTITUTO DE ARTES VISUAIS, DESIGN E MARKETING. Requerimento para autorização de criação e funcionamento da Escola Superior de Design e da Escola Superior de Marketing e Publicidade (documento interno), 1989.
- ITTEN, J. *Design and Form: Basic Course at the Bauhaus*. Revised edition. London, England; New

- York: Titles Supplied by John Wiley & Sons Australia, 1975.
- JOHNSON, L. et al. MC Horizon Report - 2014 Higher Education Edition. Austin, Texas: [s.n.]. Available at: <<http://www.nmc.org/pdf/2014-nmc-horizon-report-he-EN.pdf>>.
- JONES, D. An Alternative (to) Reality. In: CHILDS, M.; PEACHEY, A. (Eds.). *Understanding Learning in Virtual Worlds*. New York: Springer, 2013. p. 1–20.
- LANYI, C. (ED.). *Applications of Virtual Reality*. [s.l.] InTech, 2012.
- LEE, E. A. L. An investigation into the effectiveness of virtual reality-based learning. Phd—[s.l.] Murdoch University, 2011.
- MARCOLLI, A. *Teoria del Campo - corso di educazione alla visione*. 1998, 17ª ed. Milano: Sansoni Editore, 1971.
- MARCOLLI, A. *Teoria del Campo 2 - corso di metodologia dalla visione*. 1991, 3ª ed. Itália, Firenze: Sansoni Editore, 1978.
- MERCHANT, Z. et al. Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, v. 70, p. 29–40, jan. 2014.
- MOHOLY-NAGY, L. *Vision in Motion*. United States of America: Wisconsin Cuneo Press, 1947.
- MONTEIRO, R.; BARBOSA, H. Challenges Game: um jogo dinamizador do processo de ensino. In: CARVALHO, A. et al. (Eds.). *Atas do 2º Encontro sobre Jogos e Mobile Learning*. [s.l.] Universidade do Minho. Instituto de Educação. Centro de Investigação em Educação (CIE), 2014. p. 74–84.
- MUNARI, B. *Design e Comunicação Visual*. 1 edition ed. São Paulo: Martins Fontes, 1998.
- NEVES, A. G. et al. Learning Basic Design with Virtual Reality: A methodological approach. *EDULEARN16 Proceedings. Anais... In: EDULEARN16, 8TH ANNUAL INTERNATIONAL CONFERENCE ON EDUCATION AND NEW LEARNING TECHNOLOGIES*. Barcelona: 4 jul. 2016
- NEVES, A. G.; DIAS, D.; DUARTE, E. As Basic Design promotes the design learning: Featuring the Portuguese Higher Education setting. (L. Gómez Chova, A. López Martínez, I. Candel Torres, Eds.) *ICERI2018 Proceedings. In: ICERI 2018 - 11TH INTERNATIONAL CONFERENCE OF EDUCATION, RESEARCH AND INNOVATION*. Seville, Spain: IATED Academy, 12 nov. 2018
- NEVES, A. G.; DUARTE, E. Using Virtual Environments in Basic Design Education. (E. Duarte, C. Duarte, F. Carvalho Rodrigues, Eds.) *Senses & Sensibility'15: Design as a Trade Proceedings of the UNIDCOM/IADE 8th International Conference. Anais... In: SENSES & SENSIBILITY'15: DESIGN AS A TRADE. UNIDCOM/IADE 8TH INTERNATIONAL CONFERENCE*. Lisboa, Portugal: IADE - Creative University / Edições IADE, 5 out. 2015
- NEVES, A. G.; DUARTE, E. Using Virtual Environments in Basic Design Education. *The Radical Designer, n. Senses & Sensibility'15 ThRAD Special Issue*, 23 fev. 2016.
- NO AUTHOR. António Quadros (1923-1993). *Cadernos de Design*, n. 5, p. 84–86, 1993.
- Portaria nº 61/2003 do Ministério da Ciência e do Ensino Superior. *Diário da República* 13/2003, Série I-B de 2003-01-16. [s.d.]. Available at: <www.dre.pt>. Accessed on 31st May 2018.
- Portaria n.º 672/90 do Ministério da Educação. *Diário da República* 187/1990, Série I de 1990-08-14. [s.d.]. Available at: <www.dre.pt>. Accessed on 31st May 2018.
- Portaria nº 866/93 do Ministério da Educação. *Diário da República* 216/1993, Série I-B de 1993-09-14, [s.d.]. Available at: <www.dre.pt>. Accessed on 31st May 2018.
- QUADROS, A. *Escolas de Design: IADE - Instituto de Arte e Decoração. In: INII - INSTITUTO NACIONAL DE INVESTIGAÇÃO INDUSTRIAL (Ed.). Catálogo da 2ª Exposição de Design Português. Feira Internacional de Lisboa, Lisboa, Portugal: INII - Instituto Nacional de Investigação Industrial, 1973. p. 230–233.*

REBELO, F. et al. Virtual Reality in Consumer Product Design: Methods and Applications. In: WALDEMAR KARWOWSKI; MARCELO M. SOARES; NEVILLE A. STANTON (Eds.). Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques. [s.l.] CRC Press, 2011. p. 381–402.

SCHANK, R. C. Teaching Minds: How Cognitive Science Can Save Our Schools. [s.l.] Teachers College Press, 2011.

SIK LÁNYI, C.; LÁNYI, Z.; TILINGER, A. Using Virtual Reality to Improve Space and Depth Perception. *Journal of Information Technology Education*, v. 2, p. 291–303, 2003.

SILVA, A. S. DA. Modos de aprender. In: Daciano da Costa Designer. Fundação Calouste Gulbenkian ed. Lisboa: [s.n.]. p. 12–17.

SORBY, S. A. Developing 3-D Spatial Visualization Skills. *Engineering Design Graphics Journal*, v. 63, n. 2, p. 21–33, 1999.

SOUTO, M. H. Daciano da Costa e o ensino do Design em Portugal. In: Daciano da Costa Designer. Fundação Calouste Gulbenkian ed. Lisboa: [s.n.]. p. 34–41.

SOUTO, M. H. História do Design em Portugal I. Edições IADE ed. Lisboa, Portugal: Edições IADE, 2009.

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Micro influence of Learning Outcomes in Basic Design

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Abstract

Learning Outcomes (LOs) are increasingly emphasized in Higher Education (HE) systems all over the world as supporting globalization when considered at the macro scale of influence. Facing the urgent revision towards education automation, this study addresses the LOs micro-scale of influence. It can add to the setting of a solid background for innovative approaches to learning Basic Design (BD) that include, but are not limited to, digital-based tools. Therefore, we specifically aim for the identification of: i) the main components involved in each LO (i.e., levels of knowledge and content topics) as defined in the constructive alignment theory; and ii) the prominent combinations of levels of knowledge and content topics used in the Portuguese BD courses. We applied a qualitative approach, which included the use of MaxQDA software for the content analysis of the LOs from a set of Portuguese BD courses. The results revealed: i) two detailed conceptual matrixes of the levels of knowledge and content topics found in the LOs; and ii) the combinations, highlighted by frequency and importance, performed by the students in Portuguese BD courses. We acknowledge that content topics related to personal values, skills and design fundamentals are common in both frequency and importance. This micro-scale analysis opens the opportunity for the creation of BD learning experiences focused on addressing significant LOs, especially if aligned with programmes outcomes and graduate attributes. Also, other courses in the design field and other associated areas can benefit from conducting such a micro-scale analysis.

Keywords:

Portuguese Design Education, Basic Design, Learning Outcomes, Virtual Reality.

1. INTRODUCTION

Within a culture of human-technological mutual shaping (Kaplan, 2009), the evolution of design education and, consequently, Basic Design (BD), is being (im)posed by technological migration. A non-returnable movement towards education automation, as anticipated by Fuller (1964), is in constant acceleration, just reinforced by the recent urgency of new digital solutions to face quality distance learning all over the world. In this sense, we see here not only an opportunity for the emergence of innovative educational solutions from a broad perspective but, in particular, for BD.

This study takes part in a larger project that aims to develop a Virtual Reality (VR) based tool for teaching-learning BD, for which it will contribute. However, the work reaches far beyond the area of influence of any technological, analogue or digital medium, as it addresses the gap of knowledge about the LOs present at many of the existent BD courses.

With this study, we specifically aim the identification of a conceptual frame present at the Portuguese BD courses, considered both dimensions of the LOs (i.e., levels of knowledge and content topics) as defined in the constructive alignment theory. This subject was earlier addressed by us in Neves, Dias, Duarte and Ramalho (2019), which provided the basis for achieving a second objective – the definition of the prominent combinations between levels of knowledge and content topics used in the Portuguese BD courses.

1.1 LEARNING OUTCOMES

LOs can be considered descriptions of abilities expected from learners as a result of learning experiences. They are also identified as: academic goals; expected results; and learning objectives.

A set of knowledge, skills, and competencies are embodied in the LOs, which also include values, beliefs, and attitudes to be achieved by students (Dias, 2017). From the point of view of the student, LOs are intentions to act on a specific object and are, thereby, identified as Intended Learning Outcomes (ILOs) (Biggs & Tang, 2007). Three levels of ILOs need to be aligned: graduate attributes; programme outcomes; and course outcomes.

The impact of the Bologna Declaration on the Higher Education (HE) system established learning outcomes as a key instrument (OECD, 2012), that becomes a familiar and relevant expression among all the actors in the system. Next to and aligned with assessment methodologies and curricula design, LOs constitute the “Framework for Qualification of European Higher Education”. This European common structure allows the comparison between study programmes and HE institutions in Europe. The several qualification levels of the Framework are defined according to a learning outcomes approach (González & Wagennar, 2008).

It is emphasized the importance of the LOs for directing the design of learning activities by focusing on the required changes on the learners’ performance; in establishing guidelines for content, instruction and evaluation; in explicitly recognizing what is to be learned; and in delivering to learners what exactly is to be accomplished. The constructive alignment theory was created by Biggs (Biggs & Tang, 2007) and is based on the constructivist theory of learning. It is known for addressing the enhancement of teaching and learning that focus the outcomes, often referenced as outcomes-based teaching and learning (OBTL). The design of learning activities, in constructive alignment, ensures the presence of the intended verb in the outcome

statement in the teaching/learning activity and the assessment task. They are the key to the whole system. The desired outcomes of teaching specify the performance that students should achieve in terms of the level of understanding a certain content topic. SOLO taxonomy uses a list of appropriate verbs in two main categories: quantitative and qualitative, respectively corresponding the low level and high level. A pre-structural level precedes all the levels and it stands for non-existing competences. It is mostly used in the evaluation phase of the learning process. The low-level outcomes involve simple and quantifiable verbs. They are considered uni-structural level (e.g., identify; memorize; and doing simple procedures) and multi-structural level (e.g., enumerate, describe, list). As for the quality phase, the high-level outcomes are subdivided in relational level (e.g., compare/contrast; explain causes; analyse; apply) and extended abstract level (e.g., crating; theorizing; reflecting; grounding). There are appropriate levels for each level taught and, in the case of HE system, intended outcomes would be predominantly high level (Biggs & Tang, 2007). We intend to verify this idea in the context of the Portuguese BD courses by using the micro-scale analysis on its LOs.

1.2 BASIC DESIGN

The original 1919 Basic Design course, the preliminary, later called basic course, was considered as one of the main pillars of the Bauhaus Design School (1919-1933) (Bonsiepe, 2012) and, in the opinion of Cross (1983), Bauhaus' most important educational innovation. According to its creator, Johannes Itten (1888-1967), the course aimed for the students to: access inner experiences, perceptions and creative forces that would liberate them from preconceptions enabling confidence in free expression and creation; discover personal unique

characteristics by experimenting with different materials/mediums, thereby, easing their choice of career; and finally, be aware of the principles of form and colour in composition for applying them in articulation both in objective and subjective modes Itten (1975).

After one century, BD is internationally consolidated as an introductory course to the design principles, targeting first-year undergraduates in design. Nationally, recent studies identified it's permanence in the Portuguese HE system (Neves, Dias & Duarte, 2018) and revealed the presence and evolution of BD over fifty years of the design study programmes at IADE design school (Neves, Duarte & Dias, 2018).

2. METHODOLOGY

In this study, we adopted a qualitative approach to determine the most frequent combinations in the two dimensions of the LOs (i.e., levels of knowledge and content topics). The MaxQDA software was used for the content analysis of the Portuguese BD courses study plans.

2.1 SAMPLE

Forty-three study plans, from the on-going Portuguese design study programmes, were identified as carrying the BD tradition, presented by different terms (e.g., Introduction to Design; Design Fundamentals; Design I; and Basic Design Project). These BD study plans, classified according to the economic sector, HE system and type of design study programme, are presented in Figure 1. For the latter, we used the categorization from the Portuguese professional classification (Agapito et. Al, 2015) plus DG - General Design, introduced by us.



Fig. 1. Basic design courses in Portuguese design study programmes (%).

Legend: DPIE - Industrial, Product or Equipment Design; DTM - Textile or Fashion Design; DIEA - Interiors, Space or Environment Design; DGCM - Graphics, Communication and/or Multimedia Design; DG - General Design.

2.2 INSTRUMENTS

We analysed the sample using the lexical-conceptual matrixes previously created by Neves et al. (2019), which was improved for the present microanalysis. Sublevels were added from the first and second hierarchical levels. The conceptual matrixes of levels of knowledge and content topics are presented in Table 1 and Table 2, respectively. The matrix that refers to the levels of knowledge: low(1)-uni-structural; low(2)-multi-structural; high(3)-relational; high(4)-extended abstract; and undefined, use the same expressions derived from the constructive alignment theory plus the numeric code (n), for this analysis. The undefined level was created by us for associating all the verbs considered

ambiguous or doubtful and that could not be classified. As pointed earlier, the pre-structural level stands for non-existing competence, thereby presenting no verb associated to that level. For that reason, we considered it inadequate for use in this specific analysis. The content topics expression follows the same criteria and thereby, a code composed by letter and numbers (X)1.1. reference is used next to the several categories (e.g., (A)communication; (B)design fundamentals; (C)means and techniques; (D)personal values and skills; (E)historical, economic, social, cultural context; (F)project-methodology; and (G) undefined).

Table 1. Levels of knowledge matrix.

low(1)-unistructural (1)1_sensitize (1)2_define (1)3_identify (1)4_represent;draw;operate; exercise (1)5_awake; introduce (1)6_recognize	high(3)-relational (3)1_manage (3)2_express (3)3_synthesize (3)4_project (3)5_interpret (3)6_explain; justify (3)7_integrate;merge; articulate (3)8_criticize;judge;decide (3)9_organize (3)10_plan (3)11_build up (3)12_solve problems (3)13_analyze (3)14_defend; argue (3)15_apply	high(4)-extended abstract (4)1_gain autonomy (4)2_strictly master (4)3_transform (4)4_reflect (4)5_create new concepts (4)6_substantiate (4)7_design (4)8_create; compose Undefined level (0)1_understand; to know (0)2_develop (0)3_vague (0)4_no content
low(2)-multistructural (2)1_experiment; explore (2)2_acquire habits (2)3_systematize (2)4_differentiate; structure (2)5_describe; communicate (2)6_present results		

Table 2. Content topics matrix.

(A)communication (A)1_general communication (A)2_visual communication (A)3_concepts (A)4_perception (A)5_representation; expression	(D)means and techniques (D)1_analogical (D)1.1_general means and tech. (D)1.2_painting (D)1.3_mockups (D)1.4_typhography (D)1.5_drawing (D)1.6_modeling (D)1.7_handcraft (D)1.8_plastic/graphic expression (D)1.9_prototype; model (D)1.10_photography (D)1.11_paintingmaterials (D)2_analogical-digital
(B)design fundamentals (B)1_color (B)1.1_general color (B)1.2_elements (B)1.3_composition; structure (B)1.4_function (B)1.5_theory (B)2_shape (B)2.1_general shape (B)2.2_3D shape (B)2.3_2D shape (B)2.4_theory (B)2.5_function (B)2.6_composition; structure (B)2.7_relations (B)2.8_elements (B)3_fusion fundamentals (B)3.1_theory (B)3.2_function (B)3.3_composition; structure (B)3.4_relations	(E)personal values and skills (E)1_work process (E)1.1_team work (E)2_communicate (E)3_self-knowledge; self-critique (E)4_interdisciplinarity; multidisciplinary (E)5_autonomy (E)6_learn (E)7_critique (E)8_analisis; reflection (E)9_observation; to see (E)10_creativity; curiosity (E)11_delivery term
(C)project (C)1_project; methodology; product	(F)contexts (historical; economic; social; cultural) (G)undefined content

2.3 PROCEDURE

For the qualitative analysis, we used the units of text previously coded, from the Portuguese BD study plans and categorized according to the conceptual matrixes (i.e., levels of knowledge and content topics) (Neves, Dias, Duarte & Ramalho, 2019).

The connections between the two matrixes of the LOs were accessed using two procedures: (i) in the case of the sublevels, by selecting the codes and using the combine function in MaxQDA; and (ii) using excel files as they allow more flexible search by using simultaneous filters. Then, charts/graphics (see Figure 2) were created for assisting the comprehension of the results.

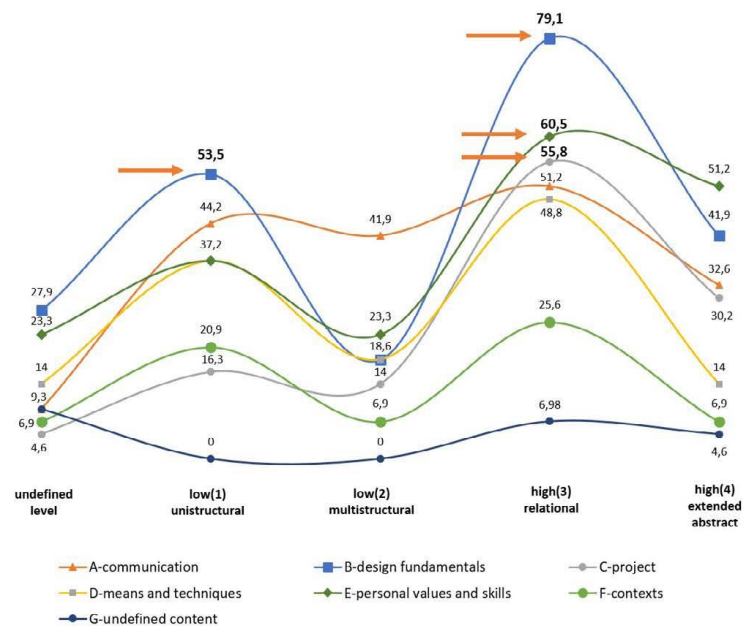


Fig. 2. Frequency of connections between levels of knowledge and content topics (%).

The Figures 3 and 4 address the high(3)-relational and low(1)-uni-structural sublevels, pointed as the most frequent levels of knowledge.

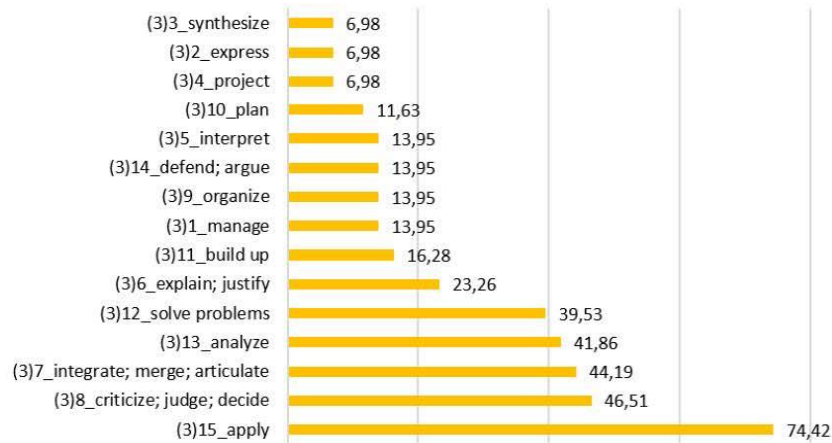


Fig. 3. Sublevels of high(3)-relational in study plans (%).

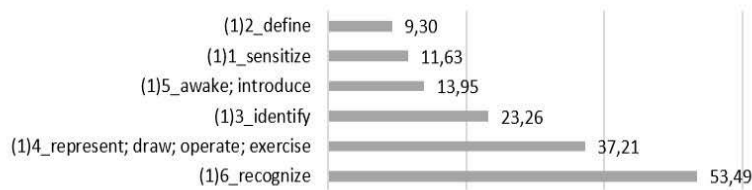


Fig. 4. Sublevels of low(1)-uni-structural in study plans (%).

Level high(4)-extended abstract, for which the sublevels are presented by frequency in Figure 5, stand for the third most represented level of knowledge. In this level, the most representative is (4)8_create and compose, with 34,88%.

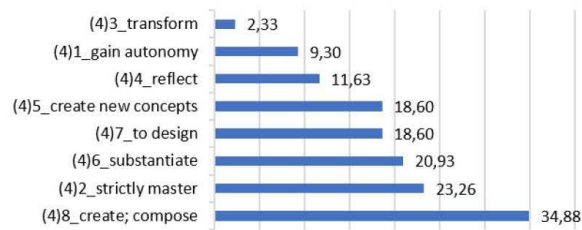


Fig. 5. Sublevels of high(4)-extended abstract in study plans (%).

Regarding the content topics matrix, (B)design fundamentals are the most frequent content topic. In the respective subcategories, in Figure 6, (B)2_shape, presents the highest frequency, with 76%, followed by (B)3_fusion fundamentals, with 65%, and by (B)1_color with 30%.

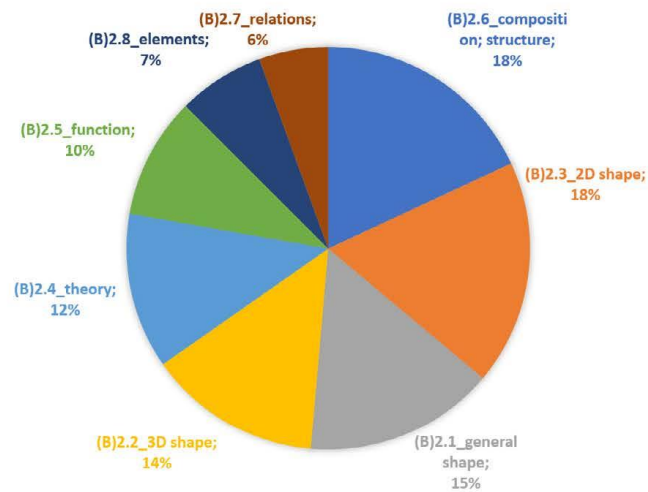


Fig. 6. Content topic sublevel (B)2_shape, in study plans (%).

The second most frequent content topic addresses (E)personal values and skills, is presented with all the sublevels in Figure 7.

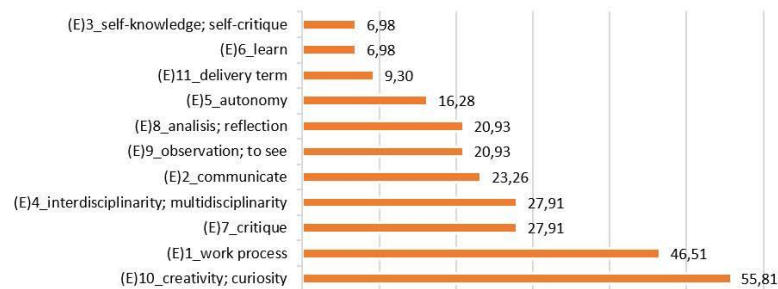


Fig. 7. Content topic (E)personal values and skills, in study plans (%).

3. RESULTS & DISCUSSION

The LOs micro-analysis of the Portuguese BD courses allowed us the identification of: i) the conceptual matrixes representing the levels of knowledge and the content topics, in the LOs; and ii) the most frequent combinations between the two dimensions of LOs: levels of knowledge (actions/verbs) and content topics (objects/content). Thereby, the high(3)-relational level, combined with the content topic (B)-design fundamentals, is found to be the most frequent, immediately followed by the combination using high(3)-relational level, with the content topic (E)-personal values and skills.

In Tables 3 to 5, we present some examples of the three most frequent combinations, using the high(3)-relational level, with (B)-design fundamentals (79%), followed by (E)-personal values and skills (60,5%) and (C)-project (55,8%), gathered from this analysis.

Table 3. High(3)-relational X (B)-design fundamentals.

Level X Content Topic	Learning Outcome	Study Plan
high(3)-relational\ (3)11_build up X (B)-design fund.\ (B)2_shape\ (B)2.6_composition, structure	"Plan the procedures needed to build less complex shapes or systems"	4 DPTE
high(3)-relational\ (3)9_organize X (B)-design fund.\ (B)2_shape\ (B)2.6_composition, structure	"Develop the ability to organize the elements that structure two-dimensional discourse"	43 DGCM

Table 4. High(3)-relational X (E)-personal values and skills.

Level X Content Topic	Learning Outcome	Study Plan
high(3)-relational\ (3)12_solve problems X (E)-per. values and skills\ (E)10_creativity, curiosity	"Appreciation of the process as a creative means for the discovery of new original solutions..."	11 DPTE
high(3)-relational\ (3)15_apply X (E)-personal values and skills\ (E)10_creativity, curiosity	"Use of creativity innovation strategies"	40 G

Table 5. High(3)-relational X (C)-project.

Level X Content Topic	Learning Outcome	Study Plan
high(3)-relational\ (3)15_apply X (C)-project\ (C)1_project, methodology	"ability to use a methodology"	2 DIEA
high(3)-relational\ (3)15_apply X (C)-project\ (C)1_project, methodology	"implementation of procedural methodologies"	16 DGCM

The second most frequent level verified in the LOs was low(1)-uni-structural level, being present in 83,72% of the study plans. This may be due to that it is an introductory first-year design course, and thereby, does not require a deep knowledge at this learning stage (Biggs & Tang, 2007). The combination of low(1)-uni-structural level with (B)design fundamentals is the fourth most represented content in the study plans (53,5%). Following, in Tables 6 to 8, we present some examples of LOs pointing the specific sublevels.

Table 6. Low(1)-uni-structural X (B)-design fundamentals.

Level X Content Topic	Learning Outcome	Study Plan
low(1)-uni-structural\ (1)6 recognize X (B)-design fund.\ (B)3 fusion fund.\(B)3.4 relations	"Recognize the concepts of measurement, scale, proportion and hierarchical relationship..."	25 DGCM
low(1)-uni-structural\ (1)3 identify X (B)-design fund.\(B)3 fusion fund.	"Identify the key elements of the field and visual language in the image, space, form and typographic font"	27 DTM

The high(4)-extended abstract level is the third most frequent level found in the LOs present in the Portuguese BD study plans (Neves, Dias, Duarte & Ramalho, 2019). According to Biggs and Tang (2007), the use of this level on the LOs is indicative of the contents expected to be performed at the highest cognitive level, thereby, revealing the most important contents to be learned and essential to the course (Biggs, 2003). As can be noticed in Figure 2, the LOs that represent the high(4)-extended abstract level are combined with the content topics (E)-personal values and skills, followed by (B)-design fundamentals, respectively, with 51,2% and 41,9%.

Table 7. High(4)-extended abstract X (E)-personal values and skills.

Level X Content Topic	Learning Outcome	Study Plan
high(4)-extended abstract\ (4)1 gain autonomy X (E)-per. values and skills\ (E)10 creativity; curiosity	"Developing student creativity and autonomy and understanding the broad concept of design"	39 G
high(4)-extended abstract\ (4)8_create; compose X (E)-per. values and skills\ (E)7 critique	"Create with authenticity and critical sense"	23 DGCM

Table 8. High(4)-extended abstract X (B)-design fundamentals.

Level X Content Topic	Learning Outcome	Study Plan
high(4)-extended abstract\ (4)5_create new concepts X~ (B)2_shape\ (B)2.3_2D shape	"Establish proportional relationships between parts and whole while safeguarding harmony and balance..."	28 DGCM
high(4)-extended abstract\ (4)5_create new concepts X (B)2_shape\ (B)2.1 general shape	"Capacity for formal and plastic abstraction"	2 DIEA

As observed, the most important content topics (i.e., the ones combined at the highest level of knowledge, high(4)-extended abstract) were also the most frequent, despite appearing in reverse order (i.e., firstly, (E)-personal values and skills, followed by (B)-design fundamentals). Likewise, we also highlight the most frequent content topics subcategories, such as (E)10_creativity; curiosity, in (E)-personal values and skills; and (B)2_shape\ (B)2.6_composition; structure, in (B)-design fundamentals. These might be considered for integrating learning experiences for the first-year design students. The results also confirm the idea advanced by Biggs and Tang (2007) that in the HE systems the outcomes would be predominantly high level.

4. CONCLUSION

In this paper, we present a LOs micro-analysis of the Portuguese BD courses that may contribute to addressing educational challenges much beyond that context. While focusing the LOs in the HE systems, we can walk through all the macro-micro scale and, thereby, afford quality learning in the

global era.

Firstly, with this study, we improved the conceptual matrixes previously created and enriched the conceptual frame. It allowed us the definition of the levels of knowledge and the content topics presented in the LOs to conduct the subsequent micro-analysis study. The conceptual matrixes represent, in some way, the structure of the Portuguese BD course, in terms of the mentioned LOs components. Simultaneously, they reveal a hierarchic conceptualization that can be useful for structuring the learning design of BD courses.

Secondly, the combinations highlighted that the content topics related to personal values and skills and design fundamentals are common in both frequency and importance. We notice that the BD Portuguese context, similarly to the preliminary course, reaffirms the importance of those contents, making them more recommended to integrate BD learning tools on a fundamental basis.

We could advance from here the development of a tool which considers a common minimum structure, informed by the most prominent combinations of levels of knowledge and content topics. The minimum structure could address the combinations: level of knowledge high(3)-relational with contents (E)-personal values and skills and (B)-design fundamentals; the level of knowledge low(1)-uni-structural with (B)-design fundamentals; and level of knowledge high(4)-extended abstract with (E)-personal values and skills.

Further developments of the micro-analysis may consider attributing hierarchical values to each combination. It would add the development of a common minimum structure shared by BD courses worldwide, adaptable to different spaces, places, circumstances, mediums, times and learning ages. It could serve several design areas, teaching methodologies and pedagogical approaches. Finally, it could support

the development of student-centred learning design tools that considers students interests, talents and creative power, in the process of becoming a designer. Each student could state a preference for a specific design area or for more than one, enabling the highest possible level of understanding topics of design fundamentals such as: formal coherence, harmony, or symmetry.

If provided by an immersive virtual environment, the experience can also allow learning to take place from direct experience, as in the real-world experiences. Winn (1993) pointed out that there is unique compatibility between the characteristics of immersive VR and the constructivist learning theory

If considered in alignment with programme outcomes and graduate attributes, this micro-scale analysis opens the opportunity for the creation of BD learning tools and experiences guided by the significant LOs for all designers that take in consideration the unique characteristics of each individual.

As already mentioned, also other courses in design education and in other different areas can benefit from conducting such a micro-scale analysis for this brad micro-macro perspective.

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REFERENCES

- Agapito, D., Almeida, H., Cesário, M., Fernandes, S., & Lacerda, A. (2015). *Design em Portugal – O perfil do designer e o papel do design nas empresas em Portugal*. Faro, Portugal: Silabas & Desafios
- Biggs, J. (2003). Aligning Teaching and Assessment to Curriculum Objectives. In *Proceedings of the International Conference on Teaching and Learning in Higher Education*. Aveiro, Portugal.
- Biggs, J., & Tang, C. (2007). *Teaching For Quality Learning At University*. England: Open University Press
- Bonsiepe, G. (2012). *Design como Prática de Projeto*. São Paulo, Brazil: Edgard Blucher
- Cross, A. (1983). The educational background to the Bauhaus. *Design Studies*, 4, 43–52. [https://doi.org/10.1016/0142-694X\(83\)90007-8](https://doi.org/10.1016/0142-694X(83)90007-8).
- Dias, D. (2017). Learning Outcomes in European Higher Education. In *Encyclopedia of International Higher Education Systems and Institutions*. pp. 1–5. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-017-9553-1_317-1.
- Fuller, R.B. (1964). *Education Automation: Freeing the scholar to return to his studies*. Southern Illinois University Press
- González, J., & Wagenaar, R. (Eds.). (2008). *Tuning Educational Structures in Europe. Universities contribution to the Bologna Process. An introduction*. Bilbao: Publicaciones de la Universidad de Deusto.
- Itten, J. (1975). *Design and Form: Basic Course at the Bauhaus*. London: John Wiley & Sons
- Kaplan, D.M. (Ed.) (2009). *Readings in the Philosophy of Technology*, Second Edition. Lanham: Rowman & Littlefield Publishers
- Neves, A., Dias, D., & Duarte, E. (2018)- As Basic Design promotes the design learning: Featuring the Portuguese Higher Education setting. In *ICERI2018 Proceedings*. pp. 7663–7671. IATED Academy. <https://doi.org/10.21125/iceri.2018.0376>.
- Neves, A.G., Dias, D., Duarte, E., & Ramalho, J. (2019). Back to the Basics of Basic Design: The Portuguese Scenario. In *Proceedings of the 12th annual International Conference of Education, Research and Innovation - ICERI'2019*. pp. 416–425. IATED Academy, Seville, Spain. <https://doi.org/10.21125/iceri.2019.0139>.
- Neves, A.G., Duarte, E., & Dias, D. (2018). Basic Design at IADE: Drawing the line. In Duarte, E. (ed.) *Design Doctoral Conference'18: TRANSgression. Proceedings of the DDC 5th Conference*. pp. 137–

144. Lisboa: IADE, Universidade Europeia

OECD (2012). Assessment of Higher Education Learning Outcomes AHELO. Feasibility Study Report, vol 1 – Design and Implementation. Winn, W. D. (1993). *A conceptual basis for educational applications of virtual reality* (HITL Report No. R-93-9). Seattle, WA: University of Washington, Human Interface Technology Laboratory.

Winn, W. (1993). *A conceptual basis for educational applications of virtual reality (Technical Report TR-93-9)* [Human Interface Technology Laboratory]. Washington Technology Center, University of Washington. <http://www.hitl.washington.edu/research/education/winn/winn-paper.html>

Anticipating the Impact of Virtual Reality for Learning the Design Fundamentals: Students' Perceptions and Perspectives

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ABSTRACT

An increasing adoption of Immersive Virtual Reality (iVR) based solutions can be observed in Higher Education and in design education particularly, namely in the teaching and learning the design fundamentals, usually referred to as Basic Design (BD). Research on this subject focuses mainly the overall potential of iVR digital technology for developing new pedagogical tools for teaching, being scarce regarding the understanding of the students' expectations about the adoption of such technology, which is essential in a Human-Centred Design (HCD) approach. The main objective of this study was to understand students' familiarity and expectations regarding the use of iVR for teaching-learning BD. An online questionnaire assessed the students' perception concerning: i) the difficulties related to the learning of the design fundamentals; ii) the suitability of the used digital technology; iii) and the receptivity/expectations to use iVR-based tools in the teaching-learning process. The results suggest that the students perceive the iVR-based tools as important and motivating for the learning process, being expected to assist the learning of all the BD-related content topics. Moreover, it is noteworthy that the most difficult content to learn appears to be 3D form, which iVR-based technologies are widely believed to aid in mastering. It is expected that the findings can support the development of learning activities assisted by iVR-based tools, more likely to meet the expectations of future students, thus contributing to engaging teaching-learning experiences and improved learning results.

Keywords: Immersive virtual reality, Basic design, Design fundamentals

INTRODUCTION

VR has been increasing its presence and importance in many educational scenarios, with doubtless positive contributions, despite being far from widely implemented in education (Kavanagh et al., 2017). The higher the immersivity of the VR system, more likely it is to provide a sense of presence, defined as a convincing sense of being, in the virtual world, indicating loss of consciousness that the body remains physically in the real world. Feeling presence is, in fact, an essential condition for effective learning. The sense of presence that is sought in VR applications, is what gives the sensation of engaging intensely and vividly in phenomena thus favouring learning. Also due this

fact, immersive technologies are expected to become more important and prominent (tom Dieck et al., 2021, p. vii).

In design education, digital technology has a key role in the transformation of educational models and processes, to which VR will be inevitably introduced as it allows access to artificial reality through the production of new objects and environments (Colucci, 2011). Therefore, VR is very likely to add to the teaching-learning of the design fundamentals (i.e., Basic Design). Research focusing the impact of VR-based tools on Basic Design (BD) pedagogy showed a growing tendency in the last decade, which will probably intensify to respond to the ongoing pandemic contingencies, as verified in the general education setting (Ball et al., 2021). Besides, the innovation factor of VR to education, particularly in the Higher Education context, makes the systematic adoption of VR technology closer to be a reality (Marks and Thomas, 2022).

The implementation of VR -based tool for supporting teaching and learning in the context of BD was approached theoretically by Neves & Duarte (2015) which lead subsequently to the development and test of a pedagogical tool in the context of a BD-derived course (Neves et al., 2016). The results of the pilot study revealed some of the factors that contributed to the non-conclusive results, such as the complexity of the task that involved coordinating pedagogical activities and experiment procedures, and others (Neves et al., 2017). The results also highlighted the quality of the experience of use through emotions detection, which revealed considerable levels of satisfaction among the students (Neves et al., 2017). The usability of VR in design education was tested by Özgen et al., (2019) during BD activities. The study reinforced the idea that VR can strongly enhance the problem-solving activities in BD context, therefore being considered a “*promising and complementary tool in basic design education*” (Özgen et al., 2019, p. 15). Another approach focused on innovative teaching in BD supported by the creation of synesthetic experiences using VR, and affording holistic learning tools (Liu, 2020; Liu et al., 2019). The artificial combinations of senses are enabled with the use of the mentioned digital technological medium, which can replace or add, the human body’s natural condition.

BD is considered the teaching-learning of the design fundamentals, which are the “*core concepts of the design approach that can be learned and improved on through practice and reflection*” (Nelson and Stolterman, 2012, p. 4). BD was created by Johannes Itten (1888-1967) who pioneered design education in the context of the first design course, at the Bauhaus School of Design (1919-1933). Design fundamentals, in the present study, coincide with the content topics, such as: Color; 2D form; 3D form; Texture; Visual principles; Personal values and skills; and Materials and techniques. Besides the content topics, the levels of understanding are the most significant building parts of the Learning Objectives (LOs). LOs are particular important in the Higher Education system, being indicative of what are the competences to be performed by the students (Dias, 2017), and therefore, to be addressed by the learning activities.

In this sense, to acknowledge students’ expectations can be indicative of possible limitations and success factors related to the learning process and

to performing the LOs (Baek et al., 2008). Questionnaires are one process of revealing users' expectations, as in the case of Bernardo & Duarte (2020). An online questionnaire enabled to evidence the familiarity of the design teachers with VR or Mixed Reality (MR), as well as their interest in learning and using VR for teaching. However, relating the students' expectations about the adoption of VR, research is scarce. Therefore, the present study aimed to assess, through an online questionnaire, the students' receptivity and expectations of using iVR for performing the LOs, in a near future, for learning the design fundamentals. Accordingly, was collected the students' perception concerning: i) the level of difficulties related to the learning of each of the main design fundamentals; ii) the suitability of digital technology used in the learning process; iii) and the receptivity/expectations to use iVR-based tools during the teaching-learning process, as well as for performing the main LOs.

METHOD

To develop VR-based tools for learning BD, according to a Human-Centred Design (HCD) approach, requires involving the users throughout design and development, as mentioned in the normative ISO 9241-210 (International Organization of Standardization - ISO, 2019). An online questionnaire was developed to access the expectations of the students towards the possible use of such tools in the teaching-learning process, including, for performing the LO's.

Participants, Procedures and Materials

58 students, 18 males (31%) and 40 females (69%), with age ranging from 19 to 28 ($M=20,45$; $SD=1,547$), volunteered in the study. They were enrolled in design bachelor's degrees in Portugal (87.9% from IADE, Universidade Europeia) and in Turkey (1.7% from Middle East Technical University, and 10.4% from Atılım University Fine Arts, Design and Architecture Faculty). All the participants had already completed, at least, one course that specifically addressed the design fundamentals. The online questionnaire was created using a free online form builder. After presenting the objectives of the study, the participants agreed to sign an informed consent. In the first part of the questionnaire, the perceptions of their previous learning experiences during BD lectures were collected, including the perceived adequacy of digital technology use. In the second part, they assisted a four-minute video presenting the iVR technology for art & design. The video was created in Adobe Premiere software using parts of promotional videos available on the internet. The collected data concerned the proficiency with iVR and the expectations towards using iVR-based tools in the teaching-learning of the design fundamentals, including performing the most characteristic LOs of the BD pedagogy.

To develop the questionnaire, we used the matrixes of levels of understanding and content-topics pointed by Neves et al. (2019) which included the most important and frequent Design Fundamentals, (i.e., the subcategories Color; 2D form; 3D form, and Visual principles); Personal values and skills, Means and techniques, and Texture. For the sections related with the type

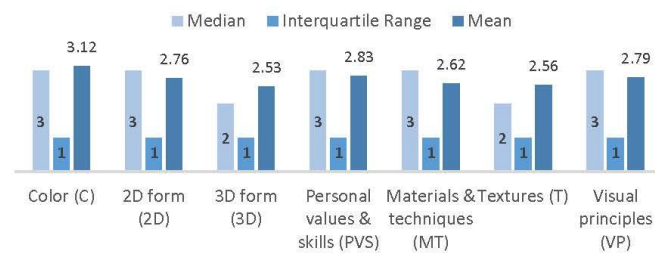


Figure 1: Perceived ease to learn the content topics.

of technology used in BD lectures, we considered the Taxonomy of Digital Technology in education (Zednik, 2020).

RESULTS & DISCUSSION

The data was analysed using IBM SPSS statistics for Windows, v. 27 (IBM Corp., 2020). A descriptive statistics was applied according to Marôco (2021). Regarding the perception of easiness to learn the content topics, participants replied using a Likert scale, from 1 to 4, indicative of “Not easy at all” and “Very easy”, respectively. Results show that Color is the easiest to learn, followed by Personal values & skills. Down the list, the content topic considered the most difficult to learn is 3D form (see Figure 1).

The results also pointed out the relative frequency of learning the 7 content topics, as some students only learned a few of them. Likewise, the less learned content is Texture, with 82.8% responses, followed by Materials & Techniques, with 94.8%. Visual principles were learned by 96.6% of the students and 3D form was learned by 98.3%. The other 3 content topics i.e., Color; 2D form; and Personal values and skills, were learned by all the participants. This data confirms the advanced by Neves et al. (2019) on the analysis to the Portuguese BD study plans, that the content topics Personal values & skills, and Design Fundamentals (i.e., the 4 content topics included in that category: Color, 2D form, 3D form, and Visual principles) are the most frequently learned. The lack of learning of Materials & techniques can be due to the pandemic contingency measures that were implemented in the latest years, privileging the digital instead of the analogic, thus limiting the access and manipulation of materials and techniques. Texture is absent from the Portuguese BD study plans (Neves, Dias, Duarte, et al., 2019), what can justify the fact that the content Textures is pointed out as the less learned of all (i.e., it was not learned by 17.2% of the students, all Portuguese). Considering the mentioned study, the fact that textures is being learned at all, comes as unexpected. One possible explanation is that the content Textures is lectured despite not being included in the analyzed study plans. Another possibility is a recent inclusion of the content topic in the design curricula.

Relating the use of digital technology in the BD teaching-learning context, participants were asked to reply using a Likert scale, from 1 to 5, meaning “Never used” to “Regularly used”, respectively. As reported, Virtual



Figure 2 (left) & 3 (right): Use of digital technology (2) & Adequacy of digital technology use (3).

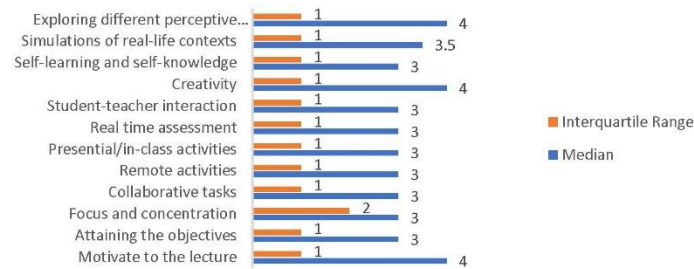


Figure 4: Perception of using iVR for the teaching-learning of the design fundamentals.

immersive tools are the least used, much as Assistive technologies. Task management tools were indicated as often used, surpassed by the Search, store and socialize, and by Authoring tools, both acknowledged as being regularly used (see Figure 2). As for the perception of the adequacy of the use of digital technology, a scale from 1 to 9 was used, representing 1, an extreme lack of use; and 9, an extreme excess of use. In general, the use of digital technology is considered adequate in all the categories (see Figure 3).

Students' proficiency in VR technology was assessed, thus revealing that 79,3% do not have any experience with VR. The remaining 20,7% had at least one experience with the digital technology, more accentuated in the Teaching-learning contexts (6.9%) followed by Random experiences or curiosity trials (5,2%). From the observed, the low proficiency with VR is not impeditive to it's use in the BD context.

As observed in figures 5-8, the content topic most expected to be learned using iVR-based tools is 3D form (97.4%), followed by Visual principles (96.5%), Color (93.8%), 2D form (92.2%), Textures (88.7%), Personal values & skills (88.3%), and finally, the least expected, Materials & Techniques (87.9%).

It is highly expected to use iVR-based tools to perform the LOs, in all 4 levels of understanding, being least expected in the 4th (91.6%), followed by the 1st and 3rd levels (91.8%). The most expected level is the 2nd (93.3%). The most frequent verb, in each level of understanding indicates Apply, in the 3rd level (27.1%); Identify, in the 1st level (29.3%); Explore/experiment in the 2nd level (32%); and Create/compose, in the 4th level (37%). Accordingly, these are the verbs that are offered to be considered in future iVR-based tools for BD.

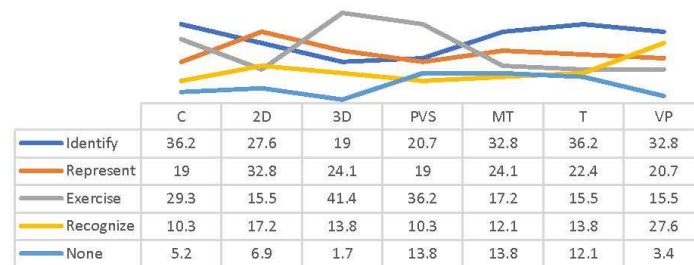


Figure 5: Expectations to perform the LOs, in the 1st level of understanding (%).



Figure 6: Expectations to perform the LOs, in the 2nd level of understanding (%).

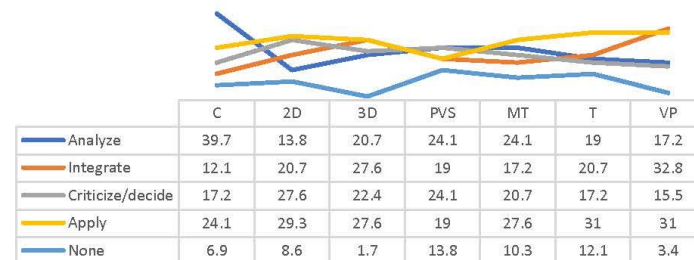


Figure 7: Expectations to perform the LOs, in the 3rd level of understanding (%).

Create/compose is the most frequent verb of the 4th level (see Figure 8), being also the most frequent of all the levels of understanding, with 37% of the participants preferences. Should be highlighted that the analysis to the BD study plans (Neves, Dias, Ramalho, et al., 2019) also points to the create/compose verb, as the most representative of all at the 4th level of understanding. The high expectation that iVR-based tools can improve creativity in the teaching learning context is also high (see Figure 4). This reinforces the probability of competences related to creativity be positively affected by using iVR-based tools, and due that fact, it can be highly recommended for developing creativity.

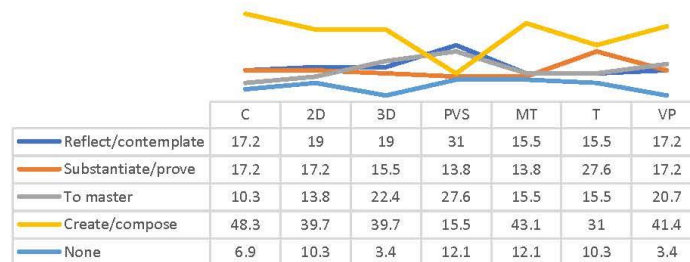


Figure 8: Expectations to perform the LOs, in the 4th level of understanding (%).

CONCLUSION

An online questionnaire enabled the identification of students' perceptions relating previous BD learning experiences, and their intentions of using iVR-based tools for teaching-learning BD. Results gathered suggest that despite the inexistent and limited proficiency of most students relating the iVR digital technology, iVR-based tools are perceived as important and motivating for the learning process, as well as highly expected to support creativity. iVR-based tools are expected to assist the learning of all the design fundamentals. However, more seems to be expected for learning 3D form, the most challenging content topic, thus suggesting that iVR-based tools are likely to add considerably to surpassing difficulties relating the content topic. The expectations to perform the LOs using iVR-based tools is high in all the levels of understanding, but more accentuated in the 2nd level where activities involving Explore/experiment are to be more welcomed, particularly if related with 3D form. Next steps can consider developing a prototype of an iVR-based tool, and testing its efficacy for learning 3D form, both with students and teachers. Hopefully, these findings will guide teachers and learning designers in developing iVR-based tools for the BD context, independently of the pedagogical approaches, which may contribute to more engaging teaching-learning experiences and improved learning results.

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REFERENCES

- Baek, E.-O., Cagiltay, K., Boling, E. and Frick, T. (2008) 'User-Centered Design and Development', in Spector, J. M., Merrill, M. D., Merriënboer, J. van, and Driscoll, M. P. (eds), *Handbook of Research on Educational Communications and Technology: Third Edition*, 3 edition., New York, Routledge, pp. 659–670.

- Ball, C., Huang, K.-T. and Francis, J. (2021) 'Virtual reality adoption during the COVID-19 pandemic: A uses and gratifications perspective', *Telematics and Informatics*, vol. 65, p. 101728 [Online]. DOI: 10.1016/j.tele.2021.101728.
- Bernardo, N. and Duarte, E. (2020) 'Design, Education, and the Online Tech-Pandemic', vol. 13, no. 03, p. 10.
- Colucci, K. (2011) 'What role will technology play in the future of design education?', in *Icograda Design Education Manifesto 2011*, pp. 63–67 [Online]. Available at http://toolkit.icograda.org/database/rte/files/PR_IEN_Manifesto2011_webres.pdf.
- Dias, D. (2017) 'Learning Outcomes in European Higher Education', in Teixeira, P. and Shin, J. (eds), *Encyclopedia of International Higher Education Systems and Institutions*, Dordrecht, Springer Netherlands, pp. 1–5 [Online]. DOI: 10.1007/978-94-017-9553-1_317-1 (Accessed 12 May 2020).
- tom Dieck, M. C., Jung, T. H. and Loureiro, S. M. C. (eds.) (2021) *Augmented Reality and Virtual Reality. New Trends in Immersive Technology*, Progress in IS, Cham, Springer International Publishing.
- IBM Corp. (2020) *IBM SPSS statistics Algorithms*, Armonk, N.Y., IBM Corp.
- International Organization of Standardization - ISO (2019) *ISO 9241-210:2019* [Online]. Available at <https://www.iso.org/cms/render/live/en/sites/isoorg/contents/data/standard/07/75/77520.html> (Accessed 26 January 2022).
- Liu, Y. (2020) 'Future Step of Basic Design: Between Synaesthesia Didactic and Virtual Learning', in Tosi, F., Serra, A., Brischetto, A., and Lacono, E. (eds), *Design for Inclusion, Gamification and Learning Experience*, FrancoAngeli, Milano, Italy.
- Liu, Y., Riccò, D. and Calabi, D. (2019) 'A synaesthetic learning approach to cave', *3rd International Conference on Environmental Design*, Marsala, Sicily, pp. 273–280.
- Marks, B. and Thomas, J. (2022) 'Adoption of virtual reality technology in higher education: An evaluation of five teaching semesters in a purpose-designed laboratory', *Education and Information Technologies*, vol. 27, no. 1, pp. 1287–1305 [Online]. DOI: 10.1007/s10639-021-10653-6.
- Marôco, J. (2021) *Análise Estatística com o SPSS Statistics.: 8ª edição*, Pêro Pinheiro, ReportNumber, Lda.
- Nelson, H. G. and Stolterman, E. (2012) *The Design Way: Intentional Change in an Unpredictable World: Foundations and Fundamentals of Design Competence*, Educational Technology.
- Neves, A. G., Dias, D., Duarte, E. and Ramalho, J. (2019) 'Back to the Basics of Basic Design: The Portuguese Scenario', *Proceedings of the 12th annual International Conference of Education, Research and Innovation - ICERI'2019*, Seville, Spain, IATED Academy, pp. 416–425 [Online]. DOI: 10.21125/iceri.2019.0139.
- Neves, A. G., Dias, D., Ramalho, J. and Duarte, E. (2019) 'Micro influence of Learning Outcomes in Basic Design', Duarte, E. and Rosa, C. (eds), *Proceedings of the UNIDCOM 10th International Conference*, Lisbon, Edições IADE, Universidade Europeia, pp. 26–38 [Online]. Available at http://senses2019.unidcom-iade.pt/wp-content/uploads/2020/12/Proceedings-of-the-10th-International-Conference-SensesSensibility-2019-Lost-in-Glocalization-final-version_medium.pdf.
- Neves, A. G. and Duarte, E. (2015) 'Using Virtual Environments in Basic Design Education', Duarte, E., Duarte, C., and Carvalho Rodrigues, F. (eds), *Senses & Sensibility'15 Proceedings*, Lisboa, Portugal, IADE - Creative University / Edições IADE, pp. 273–80.
- Neves, A. G., Duarte, E. and Dias, D. (2017) 'The impact of a Virtual Reality-based tool on teaching and learning Basic Design: Early perceptions', Duarte, E. (ed), *Design Doctoral Conference'17: TRANScendency Proceedings of the DDC 4th Conference*, Lisboa, Portugal, Edições IADE, pp. 167–174.

- Neves, A. G., Niemeyer, L., Duarte, E., Dias, D., Ayanoglu, H., Teixeira, L., Saraiva, M. and Martins, F. (2016) 'Learning Basic Design with Virtual Reality: A methodological approach', *EDULEARN16 Proceedings*, pp. 5394–5402 [Online]. DOI: 10.21125/edulearn.2016.2283 (Accessed 13 June 2019).
- Özgen, D. S., Afacan, Y. and Sürer, E. (2019) 'Usability of virtual reality for basic design education: a comparative study with paper-based design', *International Journal of Technology and Design Education* [Online]. DOI: 10.1007/s10798-019-09554-0 (Accessed 29 May 2020).
- Zednik, E. (2020) *Taxonomia das Tecnologias Digitais na Educação: aporte à cultura digital na sala de aula*, Sobral-CE, Editora SertãoCult.

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A handwritten signature in black ink, likely of Waldemar Karwowski, is positioned above the text.

Waldemar Karwowski
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