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An integrated curriculum of virtual/augmented reality for multiple design students

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Abstract

With the rapid digital developments, the practice and study of VR/AR technologies reached almost all the design disciplines by considering different applications. Therefore, there is continuous pressure on design education, where course programs in graphic design, media design, fashion design, and product design must promptly incorporate these new technologies and create complete unity between the various design professions. This paper provides a careful examination of case studies in literature and consideration of utility for the profession through a curriculum of virtual and augmented reality technologies with specifications that suit multiple areas of design (product and graphic design). This approach demystifies these new technologies from the design process to product marketing. Interviews and discussions were conducted with a sample of approximately 100 participants (60% students, 30% design educators, 10% designers, and employers). The study included different universities from UAE, Egypt, and Italy. During the academic year 2020/2021. Furthermore, the results of this research were applied to design the *Virtual Reality and its Derivatives* course within the new study plan of the Graphic Design Department, College of Mass Communication at Ajman University in the United Arab Emirates.

Keywords Curriculum Development · Design Education · Graphic Design · Labor-Market · Product Design · VR/AR Technologies

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1 Introduction

Virtual Reality techniques in the form of storytelling have been used for a long time, much longer than the technology itself, in the form of grandmother's storytelling before going to sleep or in the form of spectacles in public theatres. (Stein, 2016).

These "virtual realities" wanted the human mind to create imaginations and engage to the extent that it would be completely submerged and lose touch with "now and here." (Furth, 2011).

The more sophisticated lighting system was applied in a darker environment with the exclusive spot on the scenography (often designed itself to create optical illusions of perspective), the more an immersive experience was achieved until the arrival of the incredible invention of cinema, as ultimately animated and automated theatre. Images began to move, and it is like human perception to be particularly attracted to movement, which created the fascination we are exposed to today. (Block and McNally, 2013).

This is the long path to the invention of 2010 the Oculus Rift and its commercialization starting in 2016. Perhaps the first genuinely working VR headset that has become an individualized experience that excludes all surrounding physical space has been called "virtual reality": the main goal in creating virtual environments is to get the person focused on the narrative events as much as possible avoid distractions. In this new way, the possibilities of distraction from external factors are as limited as possible.

Consequently, the design is not just a way of making things more beautiful or more functional. Where lies the designer's responsibility, and how can one be trained to be aware of this? There is an intrinsic relation between what and how we design and how the result of it turns back to us. Taking the basic principle of ontological design, this relation becomes apparent as its claims are:

- Design is something far more pervasive and profound than designers generally recognize it, cultural theorists, philosophers, or laypersons (Uva et al., 2011)
- Designing is fundamental to being human—we design, that is to say, we deliberate, plan, and scheme in ways that prefigure our actions and makings—in turn, we are designed by our designing and by which we have created. (Heidegger, 2013)
- The aforementioned adds up to a double movement—we design our world while our world acts back on us and designs us. (Willis, 2015)

The introduction describes the research problem driving VR/AR to new and more powerful human experiences. The designers of these environments must fully understand this aspect as an essential part of managing the human mind and mitigating the transition. We must keep in mind that these applications have been accessed from the game industry studios and are spreading widely in the field of marketing and advertising, mainly to create surprise and astonishment and, later, new services related to products and their sales. VR/AR technologies

refer to an undefined area and reach almost all design disciplines by considering different applications and practices (Mohamed, 2020).

This creates pressure on design education for various fields such as graphic design, media design, fashion design, and product design. Therefore, there is an urgent need to incorporate these new technologies into students' several learning programs during their studies (Mendiburu, 2021).

A curriculum that explains virtual reality and its derivatives, such as augmented reality, will remove the lack of knowledge in modern design practice in the labor market. Virtual reality technologies have invaded many areas of mass communication and cannot be ignored anymore as essential tools. Moreover, their efficiency in providing the information is very lively on the one hand and sparks curiosity. On the other hand, the emotional involvement of viewers is guaranteed. All these aspects lead us to determine the following hypothesis:

- Full immersion in a virtual world with complete loss of connection to the physical world implies responsibility for the VR designers to gain complete control over people's minds. So, the designer's commitment extends to the resulting behavior of VR/AR users and their tools.
- We design things, services, technology, and spaces, and these elements shape the way we live and behave and implicate a profound understanding of ethical responsibility. Therefore, there is a need to integrate all virtual/augmented reality technologies in the design study program that allows many areas of design to practice these technologies objectively without being dependent on the gaming industry's interests.

Therefore, this paper identifies a way of incorporating course contents related to virtual/augmented reality into various existing design programs at the university's level, especially graphic design and product design, in a relevant undergraduate degree.

In addition to the previous, the research contribution will strengthen the labor market position of design students from various fields, such as graphic and product design, as they form a solid and advanced alternative to employers. Furthermore, the training of students on the new design process proposed in this research will point to using virtual and augmented reality technologies in various stages as a vital tool in design, manufacture, and marketing in different companies and studios. In this context; the objectives are summarized in the following points:

– Exploring new VR/AR technologies during the design and online marketing phases.
– Incorporating the advanced product marketing and promotion methods within the design process.
– Developing VR/AR educational curriculum content for a significant number of students of different design disciplines, graphic and product design.

2 Literature review

The following literature review summarizes the current understanding of integrating and using VR/AR technologies in design programs in various steps and moments of the curriculum with different approaches. In this sense, the literature review is essential to explore existing experimentations and experiences in the same field to benefit from it and improve possible mistakes or adapt to a specific situation. Further, the analyzed papers have a different value of evaluation in the current study regarding the following key points:

a) Evaluation of the need and value of the proposal itself to introduce VR/AR technologies in the new curriculum based on previous experiences and evaluation.
b) Which moment would be best to introduce the course content into the curriculum. Would it be sufficient to add a learning module to an existing course, or would it be beneficial to specify content and precise exercises to create a standalone course?
c) Which Design Curriculum (Product, Graphic, Media) is getting more benefits in holding a specific VR/AR Technologies course. In addition, which criteria would be added to each course program to cover the lack of propedeutic students' knowledge.
d) Reference Studies in literature should be related to content planning of the future course itself.

According to these key points of evaluation of case studies in literature, the following papers have been evaluated carefully by putting the following questions:

a) **Howcritical is the introduction of VR/AR technologies in the design curriculum?**

– **A study** by Mohamed, T. (2019) aimed to examine the role of augmented reality in modern E-Marketing techniques. This will be the dominant product marketing method to save time, effort, money, and excitement. The study emphasized the vital role of using virtual/augmented reality technologies as early as possible in design applications. The study used the descriptive and analytical approach to get the results and recommendations. (Mohamed, 2019) – this study refers to one of the design fields' related areas, such as graphic design for marketing
– **A study** by Hakkila et al. (2018) presented three cases about VR use technology in different courses in the industrial design curriculum at the University of Lapland, Finland. The study emphasized the importance of VR technologies as a display environment to represent the students, 3D industrial design concept models through an experimental approach without an exact curriculum. (Hakkila et al., 2018). This study supports the importance of introducing into the design curriculum of VR-technologies

– **A study** by Martín et al. (2017) discussed the role of VR technology in attracting students to the virtual 3D models' world during their study. Further, educational institutions can benefit from new accessibility of the virtual technologies to display virtual environments that are impossible to visualize in physical classrooms, like accessing virtual laboratories, imagining machines, industrial plants, or even medical scenarios. The results focused on the advantages and limitations of using virtual technologies in educational environments through a descriptive method. (Martín et al., 2017) – this study supports the practice of introducing a design curriculum with the VR-technologies.

The selected papers clearly indicate the need to introduce the knowledge of VR/AR technologies applied to design. They also point out that education itself improves the possibility to transfer knowledge in a way that physically would not be possible.

b) **What is the best moment of VR/AR Technology KnowledgeTransfer placement in the Design Curriculum?**

– **A study** by Neves and Durante (2015) focused on introducing VR technology at a very early stage in design education, especially the basic design experiments with 2D and 3D environments that were already developed during the Bauhaus period and promoted physically by Moholy Nagy (pen, paper, wood, etc.), and design elements (light, sound, space). Specifically, the students have to face the opportunity to create a new, intangible design element, such as immersion in virtual realities. (Neves and Durante, 2015). This study can be used as a reference for content planning and positioning in the curriculum

The previous examined study by Hakkila et al. (2018) also shows the benefit of introducing knowledge transfer in different courses in the industrial design curriculum at the University of Lapland, Finland.

From the presented papers, as often happens in basic studies education, the formula "the earlier, the better" also seems to be confirmed for knowledge transfer of VR/AR Technology. That means the bachelor's program, starting from half the curriculum program, becomes eligible to contain such course contents: The first part of the studies needs to introduce theoretical knowledge and basic skills. In contrast, additional tools such as software manipulation can start in the second year out of 3.

iii) **Whichdesign curriculum needs more attention regarding VR/AR technologies?**

– **A study** by AbuShawali et al. (2013) cleared that graphic design has been affected by technological developments and new digital media such as VR/AR for more effective visual communication, reflecting the graphic designer's role

and duties. The study aimed to identify the required competencies shared by graphic designers with the digital media designers in Jordan.

Also, it sheds light on the competency gap between undergraduate graphic design schools and the field of digital graphic design in the labor market. (AbuShawali et al., 2013). This study refers to related fields like graphic design and media designers.

– **The same study** presented by Ismail, T. (2019) basically investigates the correct placement in the specific design field.

The examined papers refer to the need for knowledge, especially for Media Design students and Graphic Design students. However, here the matter lies also in fact, that the third group of Product Design students already has sound experience in 3D modeling software. In contrast, Graphic Design Students might give more attention to 2D modeling but have a need in the field of Marketing. And regarding Media Design students, the question perhaps has an obvious answer for their closeness to the gaming industry, which is traditionally the one that uses more VR/AR technologies.

iv) **What kind of content should/needs to be taught todesign students in VR/AR technologies?**

– **A study** by Ansal et al. (2020) focused on the Virtual Reality (VR) development of a 3D product design tool. To control the dynamic models and provide a more improved user experience. Users can access the 3D modeling area and the toolbox through the VR headset. Users also can create the model and interact with it using their hands. These interactions are monitored, responding to the processing unit to generate the model. Once the modeling is done, the model can be saved to the system in a format supported by a 3D printer or any other format supported by a different modeling tool. (Ansal et al., 2020). This study can be used as a reference for content-planning
– **A study** by Uva, A. Fiorentino, M., and Monno, G. (2011) aimed to present a novel scenario for augmented reality based on product development integration and A.R. integrity. The product development process can offer some practical applications in critical phases, such as PLM data access, FEM simulation and visualization, joint review of design alternatives, and quality check of the produced geometries. The study used the experimental method to make the results, which focused on improving product development speed, increasing the potential for collaboration, and reducing paper sheets in the production environment. (Roger, 2016). This study can be used as a reference for content planning
– **A study** by Ye et al. (2007) presented an investigation on applying VR technologies to computer-aided product evaluation. The research work has concentrated on: investigating the potential of emerging VR based technologies such as three dimensional (3D) haptic interaction and 3D stereoscopic viewing, integrating and implementing these VR based technologies into a computer-

aided product evaluation application, and exploring the efficiency and effectiveness of these VR based technologies in comparison with traditional techniques used during the product design evaluation process. (Ye et al., 2007). This study can be used as a reference for content-planning

Once asserted that the introduction of VR/AR technologies would be a massive benefit for design students of different curricula, the main question is which content to provide in the course program to be most beneficial for the various design students. Taking for granted that the Media Design Students'program will have exceptional attention to this topic of the nature of the profession, the more important question here is how to integrate Graphic and Product Design. As later will show, the primary issue to be solved is the propedeutic knowledge of 3D modeling software in Graphic Design students compared to Product Design students.

Some significant elements can be seen as a result of the Literature Review. For example, the haptic interaction and 3D stereoscopic viewing improve the design process understanding, a faster review of design alternatives by almost realistic 3D objects, and the potential for collaboration in teams shows a better learning environment. Furthermore, experimentation with the virtual environment is preferred instead of conservatively teaching software rules. Non the less, a clear answer has not been provided.

2.1 Evaluation and criticism of the previous studies

The previous literature review highlights the need to introduce basic knowledge of VR technologies in design curricula (Mohamed, 2019; Hakkila et al., 2018; Martín et al., 2017) but does not determine the best practice scenario to do so. There are some studies focused on using virtual reality to evaluate the design in the modeling stage and usage aspects. Other studies focused on using innovative methods such as augmented reality in the electronic marketing of various products. Another study focused on using virtual reality technology in teaching industrial design and 3D model visualization judging different concepts. Another study focused on the role of the graphic designer considering the application of modern technologies, including augmented reality. Also, a study has focused on the part of technology such as virtual reality during the product design process and development procedures. Finally, others concentrated on comparing product design in the traditional method and product design using virtual reality technology and assessing their difference.

However, these previous studies did not suggest an integrated approach to VR/AR to meet the multiple design students' needs in different design professions, especially Product and Graphic Design. Neither focused on needed methodology, course program/content, or preferred study period. At the same time, the multidisciplinary team of designers can collaborate, as some studies point out (AbuShawali et al., 2013; Mohamed, 2019). Suggesting such an integrated curriculum is the goal of this scientific study.

3 The theoretical framework

Virtual Reality is an artificial environment that allows users to experience their senses and stimulate emotions in an exciting world. Virtual reality and its variations like augmented, mixed reality, and others are recent technical methods that lead to new experiences in many design areas, including product design, graphic design, and multimedia design. Historically, the term "virtual reality" was coined in 1985 by the American artist Jaron Lanier and has quickly developed as a hardware and software combination in recent years. People use VR/AR to create and develop their visual, audio, haptic, and kinesthetic experiences. (Josef, 2013).

3.1 Overlapping between virtual and augmented reality

Augmented reality technology is considered a derivate of virtual reality that relies on virtual objects' projection into the real environment to provide the users with additional information as a direct translation of augmented meaning. It supports VR technology itself with less immersion but huge possibilities for application.

Augmented reality technology takes a part of the facts and experiences the users go through in their daily lives and enhances some additional information. Both technologies (virtual, augmented reality) can be combined and used in so-called mixed reality in such cases, where the real scenes can be kept while adding some other virtual elements. The users still see some of the natural-real natural environment places, and they can add new features to the entire set through mixed reality applications; for example, a virtual piece of furniture is placed in a real scenario to evaluate the purchase decision. (Michel, 2013).

Interaction capacity plays a role in developing virtual and augmented reality techniques as it focuses on meaningful communication of the media with the audience (people and technology). Successful interactive design (software and hardware) needs to be evident and straightforward with specific goals. Therefore, interactive design's creative possibilities lie in the excellent use of multimedia elements for a high communication level, such as texts, images, videos, sounds, and other visual techniques. (Juan, 2014).

In general, VR/AR technologies offer several benefits to designers, customers, employers, etc., which increases the capacity of business as follows:

- Providing additional information to designers during and after the design process to faster develop and bring the products to market.
- Innovatively presenting products' concepts with higher efficiency of interaction and real-world allocation simulation
- VR/AR contributes to innovative advertisements and promotional methods for various products, positively affecting companies' and producers' policies.
- Customers show the products virtually to make their purchase decision and increase their participation, so they have a personal experience assessing product quality, which affects their happiness.

- Building a proper mental image in the customers' heads deals with the dynamic visual elements.
- Supporting online retail, especially global sale channels and retail for minority groups who have difficulty reaching shops quickly.
- Respecting consumers' privacy when purchasing personal products.

These are core elements to be considered, evaluated, and planned for the course content to match market needs and designers' improved knowledge of advanced design methodologies and tools.

3.2 VR/AR applications in product design and marketing process

The rapid improvement of computer technology and various applications contributed to the significant development of VR/AR. The intelligent devices (for designers and customers) are constantly getting smaller, lighter, more efficient, cheaper, and higher in 3D graphics quality. (Barbara, 2017).

There are several methods and techniques that applications of VR/AR use to showcase and promote the products during the design, manufacturing, and marketing process, such as:

- Virtual reality design applications can help designers with the 3D visualization of products and their various parts with a presentation in their real environment during the design process, as shown in Fig. 1. (Dent and Sherr, 2015) This improves the design quality, and the speed of reaching final solutions will be fast so that the correct executive decisions can be taken.

Fig. 1 Shows that VR helps designers make their design decisions

Such virtual prototyping is highly cost-efficient compared to actual modeling or prototyping. Furthermore, although it would not substitute a final physical product to evaluate physical interaction, the virtual rendering supports understanding of complex design items in the early stages, avoiding repeating the same and same models. (Martín et al., 2017; Roger, 2016).

- Applications of displaying new furniture at home before the purchase like; **Houzz, Housecraft, ARule, etc.,** measure the dimensions of spaces, volumes, and heights between different pieces of furniture to suggest the best solution to the customers.
- Further use is done by the IKEA application that views the disassembled furniture pieces in the boxes as an interactive entire, finished unit, allowing customers to test the location of the furniture at home.
- Applications for designing interactive children's stories, specifically VR/AR applications, convert the designed graphics on children's products and furniture into dynamic interactive viewed stories.
- Dynamic augmented reality advertisement applications are used to present products in the way that their physical components and ingredients move on the Mobiles' and Ipads' screens, as shown in Fig. 2. (Wild et al., 2020)
- AR Applications are used instead of clothes fitting rooms, where customers can virtually measure their clothes without using physical cabins in the shopping.
- Floating hologram 3D techniques make objects viewed in space without glasses or optical instruments. These high-quality projections will be the next generation of advertising and product marketing.

According to the webpage Statista (https://www.statista.com, retrieved in 2022), the augmented reality market amounted to 16.8 billion U.S. dollars in 2019. The massive success of its applications is anticipated to expand drastically, with estimates to reach 160 billion dollars by 2023, as shown in Fig. 3.

Fig. 2 Shows some A.R. applications in advertising and modern marketing of products

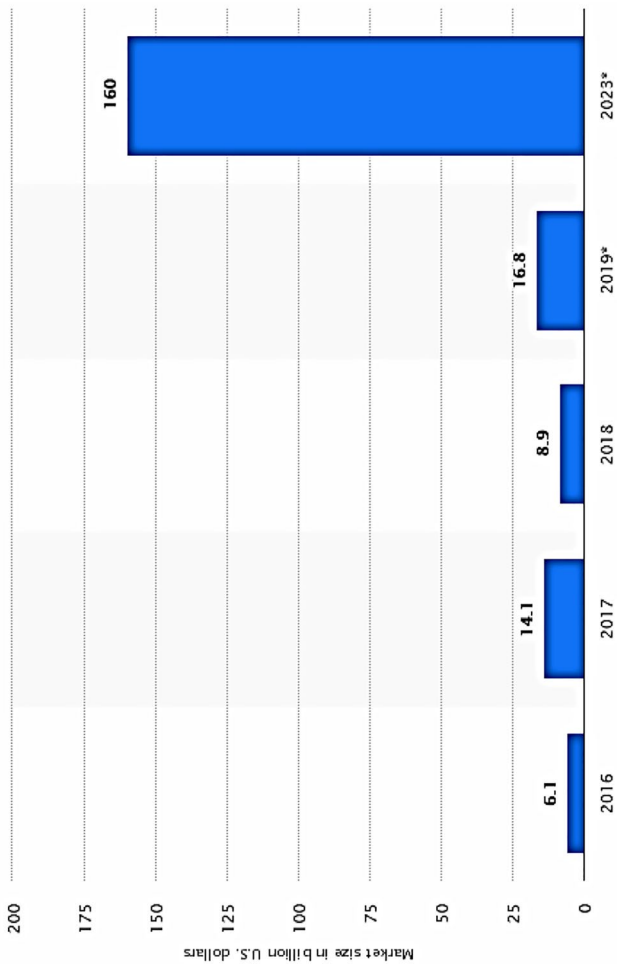

Fig. 3 Shows the market size with the use of the augmented reality

4 Research methods

4.1 Research design

Based on the goals of this paper, the study is divided into three parts. The first part includes a literature review with previous studies of the VR/AR meanings, applications, and importance to design education. In the second part, interviews and discussions were conducted with students of different design fields (especially graphic and product design students), design educators in various institutions, designers, and employers in the labor market. They were all invited to introduce their experiences and opinions in answering questions derived from the paper's objectives and hypothesis. The questions addressed the VR/AR techniques in the labor market and their relationship to multiple design education. Conducting such discussions, specifically among the targeted participants, plays an essential role in creating fundamental concepts about the importance of VR/AR for design students of different disciplines. Furthermore, preparing an inclusive educational curriculum with theoretical and practical content is discussed in the third part of this paper.

4.2 Participants

The survey participants include students, design educators, designers, and employers. They are from different fields of design (graphic and product design students at Ajman University and Bologna University). They are between the ages of 18 and 22; the number of males and females is balanced. The languages used for the interviews were Arabic, English, and Italian. These mixed students' opinions enriched the research with different views, guided by different experiential and educational backgrounds and visions of the labor market. Thus, in addition to several design educators, designers, and employers. Furthermore, it has been considered that the participants have their personality and personal responsibility to evaluate the course proposals or experiments and to decide about the content. The participants were approximately 100 people (60% students, 30% design educators, 10% designers, and employers).

4.3 The participants' selection criteria

Conducting such interviews and discussions with students of educational institutions in different design fields (graphic and product design) and design educators, designers, and employers yields that they are independently criticizing. And assessing any design topics directly affected by this study's results.

4.4 Research restrictions

The research's spatial borders crossed the United Arab Emirates by involving participants were from different countries, such as Italy, with various cultures to enrich the research results. Research interviews were carried out with an inhomogeneous

group of design students (graphic and product design) as well as professionals with sometimes different educational backgrounds. Therefore, expectations might be expressed individually. Some of these interviews were conducted face-to-face, while others were online without being limited to a specific location. These two parameters (international participants instead of local, face-to-face, and online interviews) can also be seen as limitations as single contributions might differ much from one another. Nevertheless, it was also the aim of the research, as long as the discussions revolved around one specific topic: creating a VR/AR reality curriculum that can be used in different areas of design and labor markets.

4.5 Research instruments and data analysis

Qualitative and Quantitative interviews and discussions are suitable methods for collecting statistical data and knowing more details about different participants' opinions, especially since there were no restrictions on expressing thoughts. All participants ' responses were collected and analyzed during this process. The most common responses were highlighted and compared to each other and were structured. The statistical system was used for those response categories where percentage allocation is required, and the results were grouped into consecutive tables to show their relations. The participants were asked to answer the following questions:

– **Do you think a unified curriculum of virtual reality and its derivatives will be helpful to multiple-design disciplines students?** The following Table 1 shows the respondents' percentages of those who agree, agree to some extent, disagree, and do not know.

The previous table shows that most participants agree on preparing a unified curriculum for students of different specializations to contribute to the convergence of viewpoints and help them integrate within large teams in the labor market, which includes many designs disciplines. And it is observed that there is a negligible percentage that disagrees or does not know of that.

Table 1 Clarifies the participants' opinions percentages about question No. (1)

Participants	Agree	Agree to some extent	Disagree	Do not know
Students	90%	8%	1%	1%
Design Educators	93%	6%	1%	0%
Designers	92%	8%	0%	0%
• Employers	• 89%	• 9%	• 1%	• 1%

Table 2 Clarifies the participants' opinions percentages about question No. (2)

Participants	Product Design	Graphic Design	Interior Design	Fashion Design
Students	45%	40%	12%	3%
Design Educators	40%	35%	20%	5%
Designers	37%	30%	23%	10%
• Employers	• 35%	• 35%	• 17%	• 13%

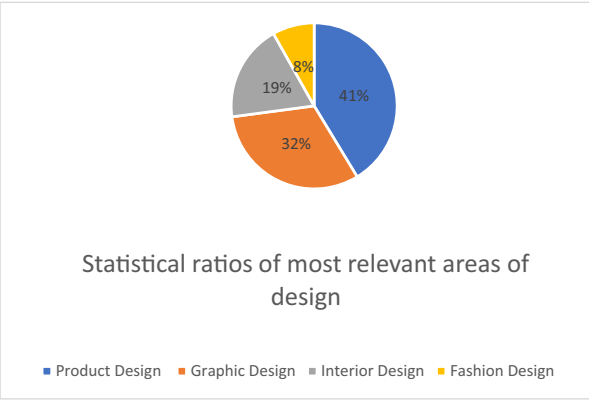

Fig. 4 Shows statistical ratios of the closest relevant areas of design

– **What are the most relevant areas of design that could be incorporated into this curriculum?**

In this question, four majors that are most prevalent in Art and Design Colleges in Egypt and the UAE were identified to examine the possibility of applying this curriculum to them. The following table 2 shows the Statistical percentage of participants' answers in ordering the closest design fields to each other in the labor market.

This question's answers show that graphic design and product design are too close due to the labor market features. The developments in the labor market require compatible designers' teams from different professions to understand each other successfully. Therefore they can achieve their missions from the viewpoint of customers, clients, and employers. The changes in the current educational programs plans due to the new features of the labor market will be the influencing factor to enhance the corresponding characteristics and skills of the new designers' generations.

On the other hand, the product designer's responsibility is to create forms that fulfill consumers' emotional and physical desires, so the product must be easy to use, utilitarian, and have good-looking, and safe at the same time. Furthermore, the product designer has become dependent on modern technologies during the design process, including VR/AR. Since the design process is a continuous process in all its stages between product design and its promotion, it is essential to emphasize that

product designers and graphic designers complete the work of each other. The previous values can be simplified as in Fig. 4.

Discussions revealed many common characteristics in graphic and product designer personalities. Each has an insightful vision to create new relationships from the various design elements. Whether on the two-dimensional or three-dimensional level, as follows: -

- Observing and perceiving all visible physical relationships in objects
- Imagining all the invisible relationships and linking them together.
- Having multiple mental skills such as logic in thinking, cognitive organization, and fluency of ideas. They all reflect in the quality of the design
- Estimating the right proportions, dimensions, volumes, and relationships between shapes and colors and translating them into innovative products and advertisements.
- Possessing manual and mental skills while practicing the traditional or computer-aided design process

One, perhaps only, significant difference in using VR technologies by graphic or product designers lies in the understanding of VR as a tool for.

- Visualizing only from a graphic point of view an environment or object (graphic design)
- Interacting with virtual prototyping to understand complex relations of single parts to the whole during the design process (product design)
- **Do you have previous experience with VR/AR?** The following Table 3 shows the respondents' percentages of those who have and have to some extent or do not have.

The previous table shows that most students, design educators, designers, and employers do not have actual experience with VR/AR but at different rates. This demonstrates the urgent need for the educational course on VR/AR to improve the students' perceptions and hence designers to meet the future labor market needs. The percentage increases with employees reaching 43% knowledge confirming the use of technologies in the market.

Table 3 Shows the participants' opinions percentages about question No. (3)

Participants	Have	Have to some extent	Do not have
Students	10%	15%	75%
Design Educators	20%	25%	55%
Designers	15%	20%	65%
• Employers	• 23%	• 20%	• 57%

In the coming stages, the presented questions were directed mainly to the students involved in graphic and product design programs and discussed the technical details of the proposed curriculum content as follows: -

– **Do you have any skills in 3D design by the computer?** The answers percentages are shown in Table 4.

The previous table shows that all product design students have their skills in 3D design by computer except for a few, and a smaller percentage of graphic design students have these skills. Therefore, it might lead to the necessity, after careful examination, the integration of propaedeutic introduction to 3D design for graphic design students.

– **Have you practiced marketing methods using VR/AR for products?** The answers percentages are shown in Table 5.

The previous table shows that neither design professions have enough experience with marketing methods using VR/AR for products. So, the curriculum content should have topics and practices about marketing methods using VR/AR.

The next question was directed to the students, design educators, designers as follows: -

Table 4 Shows the participants' percentages about question No. (4)

Participants	Have	Have to some extent	Do not have
Graphic Design Students	40%	35%	25%
Product Design Students	80%	15%	5%

Table 5 Shows the participants' percentages about question No. (5)

Participants	Have	Have to some extent	Do not have
Graphic Design Students	25%	20%	55%
Product Design Students	10%	15%	75%

Table 6 Shows the participants' percentages about question No. (6)

Participants	Yes	No	Do not know
Students	65%	5%	30%
Design Educators	85%	10%	5%
Designers	70%	10%	20%

– **Do you think the marketing process using VR/AR should be incorporated into the design process stages?** The answers percentages are shown in Table 6.

The previous table shows that most design educators, students, and designers consider incorporating product marketing using VR/AR in the design stages.

The following question was directed to the designers and employers.

– **How much do you rely on VR/AR in designing and marketing products?** The answers percentages are shown in Table 7

The previous table shows that; most designers (60%) and employers (55%) are looking to use VR/AR in designing and marketing products.

The following additional questions were directed to all participants to determine more curriculum details. It has been statistically processed and included in the paper results: -

– **Do you think the term "virtual reality and its derivatives" is appropriate to be the name of the curriculum?**
– **What are the expected educational outcomes from this course?**
– **Is the historical approach to virtual reality and its derivatives important to you?**
– **What are the differences/similarities between virtual reality and augmented reality?**
– **What are the common aspects of the use of product designers and graphic designers?**
– **What are the required characteristics of new designers to use the VR/AR techniques?**
– **How should the curriculum content be structured according to your expectations?**
– **What are the number of credit hours, contact hours, and prerequisites?**
– **What are the futuristic duties of graphic and product designers?**
– **What are the necessary physical requirements for the success of the curriculum of VR/AR?**
– **What are the tasks of the graphic designers through VR/AR techniques?**
– **What are the tasks of the product designers through VR/AR techniques?**
– **What are the essential topics, practices, and assignments of the VR/AR curriculum?**

Table 7 Shows the participants' rates about question No. (7)

Participants	Often	From time to time	Never
Designers	25%	60%	15%
Employers	20%	55%	25%

– **How can the new educational curriculum meet the current interactive designing and marketing requirements?**

5 Results and discussions

According to the previous theoretical study, interviews, data analysis, etc. There is an apparent gap in the reviewed literature and earlier studies on the lack of preparing an integrated curriculum that can be taught to different areas of design students, such as product and graphic design. Integrating students in various fields of design to study this course will develop the spirit of teamwork to cooperate in product design, visual advertising, and marketing in the labor market, which is a primary goal in this curriculum. So the respondents' answers determined the scope of the VR/AR curriculum features and contents. And in summing up the results, it is decided to combine similar answers into specific categories arranged in random order, and the results can be classified as follows: -

– A significant part of the participating students sees their theoretical and practical experiences are limited in VR/AR and its technology. Still, they had higher expectations of how VR/AR could be used in their futuristic work as designers in the labor market.
– The participants cleared that they were exposed to VR/AR content only in rare cases when dealing with design technology. Therefore, accurate, in-depth theoretical and practical information in this field would be needed and integrated successfully into the design process.
– The participating students of Ajman University and Bologna University had previously been exposed to a short knowledge of 3D generating files and animations. A cast of expertise would be provided in this curriculum to close the knowledge gap for a few who lacked understanding. Generally, it has been defined as basic knowledge as follows: -

    - Principles and basics of design
    - Software for 3D design construction
    - Design and animation of the elements and characters
    - A capacity for three-dimensional imagination and visual content handling using VR/AR applications

– Due to the participants' responses, the expected educational outcomes of this curriculum are that students should have the following skills: -

    - Use theoretical knowledge to developmental and cognitive perception capability in VR/AR.
    - Link the areas of VR/AR with graphic and product design topics, including specializations in cultural heritage, service design, etc.
    - Be able to use the methods of projects by VR/AR technologies and applications.
    - Do practicing the design process concerning VR/AR technologies
    - Apply the different rules of VR/AR to design and produce, marketing various projects and themes.

- Be able to integrate the VR/AR applications in an industrial and cultural context to communicate effectively with team workers, employers, and customers.

– The participants determined the course duration; partially, it will be taught for one semester during the students' study years, two lectures per week (one theoretical hour, four practical hours). So that student can achieve their practices and various experiences in dedicated labs with VR/AR technology, equipped with all physical capabilities like computers, screens, projectors, headsets, sensors, glasses, treadmills, etc., and applications for the students' use in theoretical and practical lectures.

The participating students, design educators, designers, employers identified the requirements for the success of the curriculum of VR/AR and its characteristics as follows: -

- **Functionality**: The course must be effective in achieving the goals of design education and its current outcomes
- **Flexibility**: The educational content must be changeable in its parts and continuously adapt to the labor market developments
- **Comprehensive**: The course should contain a lot of information covering all theoretical and practical aspects of VR/AR techniques for different design professions
- **Simplicity**: The course should simplify the complex technical concepts of VR/AR to allow easy understanding.
- **Integration with other courses**: the course contents should not be independent of other courses and aim to achieve its educational goals and outcomes at Ajman University and Bologna University
- **Variety of approaches**: the course should include a variety of topics, exercises, etc., compatible with the dynamic labor market, as well as the spirit of teamwork involving many designers from different design areas.
- **Empiricist:** The course contents need to have several practical project briefs to be related to the labor market

Figure 5 shows the different values of the VR/AR curriculum characteristics due to the viewpoints of the participants' responses.

The previous graph shows the following results of the VR/AR curriculum characteristics: -

– The comprehensive value got 24% because the curriculum topics must be comprehensive and convenient for most design fields.
– The flexibilityvalue got 19% because the flexibility value is vital as the curriculum includes aspects of technology that need to change and continuous development.
– The Variety of approaches value got 18% because the curriculum should have a variety of topics and practices to be compatible with multiple design fields and labor markets.
– The functionality value got 12% because the curriculum content should achieve different goals and outcomes.
– The empiricist value got 10% because the curriculum should be applied study, so the students need to do different VR/AR lab experiments.

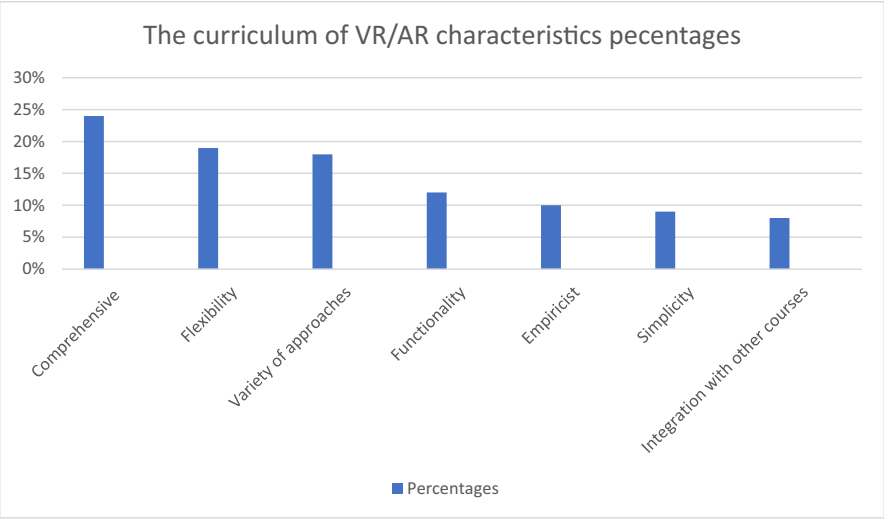

Fig. 5 Shows the percentages of VR/AR curriculum characteristics

- The simplicity value got 9% because it is known that students have some anxiety about new knowledge. So, they need the simplicity of information and experience for more understanding.
- The integration with other courses' value was 8% because some curricula need prerequisites and overlapped with other classes.

6 Conclusions

In light of the interviews' results, further discussions were held with various graphic and product design educators and experts in VR/AR Techniques; the final conclusions of the curriculum description and Specifications are as follows: -

a) A scientific curriculum deals with virtual and augmented reality topics to help students understand the relationships between the real and virtual worlds and incorporate these technologies in the design process and presentation skills.
b) The proposed course specifications are appropriate for some design fields using various visual techniques, such as; product design, graphic design, and multimedia design.
c) This course is three credit hours per week (one theoretical hour—four practical hours), whereby every two practical hours correspond to one academic hour.
d) Before the students start this course, they must study 2D and 3D basics courses for graphics as a course prerequisite. In addition, product design students must have completed a minimum level of 3D Design in their curriculum.

e) Students will create a three-dimensional interactive environment; elements are made from characters, components, backgrounds, lighting, sounds, various effects, etc. The course will also introduce using the best existing 3D model libraries and other online tools.
f) The practical study also includes the physical technologies and virtual/augmented reality tools that immerse students in their designed concepts during the design process.
g) The curriculum qualifies students to make decisions about their ideas at different stages of the design process. In addition, it provides them with a realistic view of using this technology in current labor markets. Using VR/AR techniques in the design process's phases translates the design ideas from a 2D environment to an interactive 3D environment. Therefore, the students should use this technology to assess their ideas during the design process, as shown in Fig. 6. Thus, using the Virtual and Augmented reality techniques became an essential part of the design process.

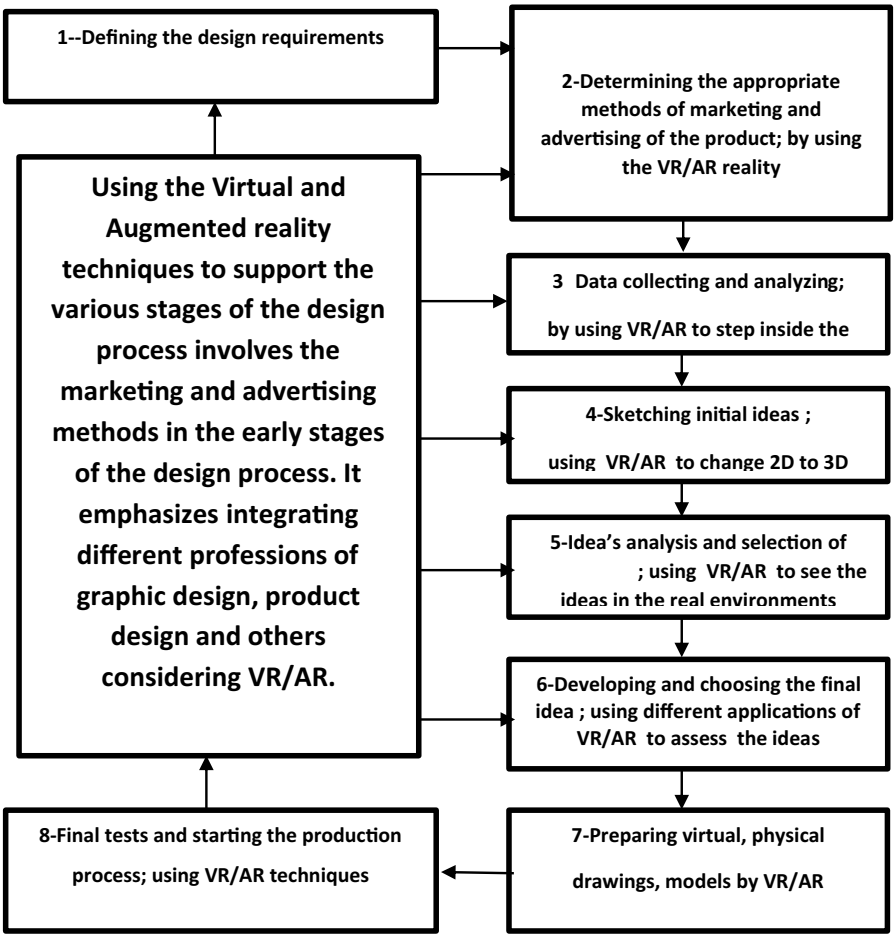

Fig. 6 Shows the design process using VR/AR technology

In the previous Fig. 6, VR/AR provides technical support to the designers through various design process stages. Where the drawings, sketches, virtual models, etc., can be converted and placed into the designed product's real environment so that multiple tests and evaluations and marketing methods can be carried out, it should be performed at each design process stage to provide the final data and decisions about the quality of the proposed design before the final decision, and production processes start.

7 Recommendations

Based on the research results, discussions, and conclusions, it is recommended that: -

- VR/AR's new design innovation methods must be taught to various design professions to exchange ideas and experiences easily.
- It results that in the market, there is a growing need for specifically graphic design students to be familiar with VR technologies to close the gap of difficult accessibility due to missing knowledge. So the Curriculum must integrate with an appropriate introduction of 3D modeling software as a base for advanced expertise in VR technologies.
- Providing the knowledge of VR/AR at the university grades that are related to the new interactive labor market.
- Giving a chance to the increased role of VR/AR in the interactive digital marketing and design process by defining the marketing methods at the beginning of the new product design process and their requested procedures.
- Due to VR/AR use and its technology in product design and digital marketing, it is vital to partially incorporate some work teams from different design professions (e.g., product and graphic design), especially during the product design process stages.
- As per the capacity and impact of VR/AR technologies, the knowledge needs to be delivered in a certified way to guarantee coherence with the designer's ethical and professional responsibility.

Declarations

Conflict of Interest None.

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Important note This scientific paper and content of studies, analysis, results, and recommendations have been approved as a guide for designing the curriculum "Virtual Reality and its derivatives" for the graphic design students at the College of Mass Communication, Ajman University, in the United Arab Emirates. Therefore, this course syllabus has been attached to this scientific paper for publication.