

The Impact of Augmented Reality Tools and Techniques on the Imaginative Thinking Routines of the Arts and Design Students, and its Relation to the Accuracy in Learning and Achievement Level

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Abstract

The paper in hand aims to examine and explore the effect of augmented reality tools and techniques on developing imaginative thinking behavior, across arts and design students, as well as its relation to the accuracy in learning and achievement levels. The study was conducted in the faculty of arts and design in Jordan University. This paper manifested the possibilities that augmented reality can offer to education. Not only that but also the suggestions which affect teaching and learning strategies; it also can cater to students' educational needs and provide solutions, while the learners develop their designs. Such programs define innovation from a different perspective, and considers development as a mean to cope with the changes in the world. In order to achieve the aims and objectives of the study, the researcher developed imaginative thinking and achievement tests. (40) Students took the tests. As the researcher implemented descriptive quasi-experimental design for its appropriateness to the nature of the study.

The results of the study demonstrate a statistical analytical significance in imaginative thinking sections, as well as the students' success in the posttest achievement tests; this process was in favor for the experimental group. The experimental group members enjoyed learning as they received augmented reality techniques and developed designs digitally. Due to the high achievements and high scores of the experimental group, the researcher highly recommends the professors to include such programs in their teaching and learning processes.

Key words: augmented reality techniques, imaginative thinking, and achievement level, learning accuracy, arts and interior design students.

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Introduction

The twenty first century featured and exhibited numerous technological developments. To begin with, the digital economy, as it supports the prosperity of the artificial intelligence, due to its enormous impact on our daily lives, especially the learning and teaching processes. This impact will change our approaches to learn, work and live forever. Therefore, it is highly essential to perceive change with an open mind and pave the path for new and innovated designs to thrive and prosper. Hence, the contemporary demands of the new age will need a creative designer who is completely aware of the technological significance. Without technological tools, the contemporary designer will be able to develop skills nor imagination. (Anderson&Elloumi, 2017)

Technical and technological growth are becoming the reality we currently know. Moreover, the world citizens can communicate via internet platforms, in order to exchange experiences and reciprocate knowledge. Such change has highly affected the capacity of communication, especially in the education sector. It made people reconsider learning and teaching methods. Therefore, a number of university professors came across an extremely high challenge finding the appropriate technical tool to use or the software to implement and follow, in order to help the upcoming generations. (Barreira et.al, 2019) .

Interior design education lead to computerized designs, and then new design software emerged in the market. At this point, the awareness and significance of augmented reality as well as imaginative behavior was not clear enough. Only because the skills differ across the students. For example, some can visually connect the space to the proportions and the surroundings. This will widen the perspective and will allow imagination to grow beyond the limits of the classroom. (Bogen et.al, 2016)

This study exhibits new educational design methods to interior design, which are accustomed to contemporary means of development. Augmented reality plays a key role in facilitating the design process, as it also offers an agreeable ground for both the student and the professor or the designer and the client. (Catenazz&Sommaruga, 2018)

The key role for augmented reality is to create a distinguished and individualized design. However, the question remains if the imaginative growth will be affected positively? Will imaginative thinking and achievement levels correlate? Will this go along with learning accurately? Can augmented reality upgrade the imaginative thinking behavior? Therefore achievement levels and accurate learning?

Study Issue:

Rapid and fast changes are happening. Simultaneously, the human needs are also growing and changing. Interior Designers and professors aim to eliminate and minimize the gap between imagination and real implementation. This will provide solutions and more benefits in the education field. Augmented reality must co-occur with education for effective learning and teaching. This might cater for the student educational need, support the lesson plans, and upgrade the outcomes, for better achievements.

Creative, imaginative thinking behaviors are the main factors to produce an artistic and individualized design. A standout design consequently distinguishes the designer. As the designer can construct more than one interior design concept communicating with their audience on a new level. Students are simple and raw thinkers. It is essential to guide and mold their skills in order for their imagination to thrive; consequently, they will achieve better results. (Chen, 2016).

The conventional educational means will no longer work when teaching and learning interior design, given to the nature of the specialty, besides such means don't align with the objectives of the design process because conventional methods do not respond to problemsolving approach, unfortunately this resulted in creative and cognitive shortage

Augmented reality provides a fair chance for all the involved parties –students and professors - to communicate their concepts and imaginative ideas; however, students tend to drift away from the main objective. This encouraged the researcher to investigate the impact of augmented reality tools and techniques on the imaginative thinking routines of the arts and interior design students, and its relation to the accuracy in learning and achievement level. (Chang et. Al, 2017).

This paper sought to find solutions and respond to the following question: What is the impact of augmented reality tools and techniques on the imaginative thinking routines of the arts and interior design students, and its relation to the accuracy in learning and achievement level?

In reference to the scope of this study four hypotheses were formed:

- 1- There are no significant statistical differences at the level ($\alpha \leq 0.05$) between average score of art students among the experimental group (the ones who studied and implemented augmented reality) and controlled group (the ones who studied the specialty ordinarily) in the post thinking test for the arts and design students in the University of Jordan.
- 2- There are no significant statistical differences at the level ($\alpha \leq 0.05$) between average score of art students among the experimental group (the ones who studied and implemented augmented reality) and controlled group (the ones who studied the specialty ordinarily) in the achievement test for the arts students in the University of Jordan.
- 3- There are no significant statistical differences at the level ($\alpha \leq 0.05$), between the average score of art students. The students among the experimental group, (the ones who studied and implemented augmented reality), and the students among the controlled group (the ones who studied the specialty ordinarily), in learning accuracy, for the arts students in the faculty of arts and design after the posttest in the University of Jordan.
- 4- There is no correlation between imaginative thinking growth and achievement levels and the learning accuracy for the arts students in the faculty of arts and design in university of Jordan.

The objectives and aims of the study:

This study aims to identify the impact of utilizing augmented reality on the imaginative thinking behaviors of the arts students in the faculty of arts and design in the University of Jordan. Clarifying the correlation between developing imaginative thinking growth and achievement levels as well as learning accuracy.

The study delves into the nature of design as a subject. Determining the challenges, in which the professors encounter when teaching the subject conventionally. As the researcher believes that, the deployment of augmented reality will more likely support the students and will help them get better grades and outcomes.

Significance of the study:

Such updated software and digital systems have high impact on teaching pedagogies. The interior design as a subject manifests a visual nature; therefore, augmented reality can be one of the methods to follow in order to meet the market demands. When augmented reality software is applied, designers exhibit different levels of creativity. Augmented reality represents the designs as expected to exist in real life, demonstrating light, proportions, texture and true colors providing a vivid visual experience for the students. E learning is the most essential modern development, as it encompasses technicalities and technological tools, which facilitates educational purposes.

The third international conference for E learning and distant education (2015), the fifteenth scientific conference executed by the Egyptian Association for technology learning (2015). Encouraging and recommending

with high consideration to provide interactive digital environments and deploy them in education to cater for the students changing educational needs. (Chen&Tsai.2020). This will evoke imaginative thinking, because the students will practice and develop tangible learning experiences. This will also help the researcher to determine the correlation between the imaginative thinking growth and achievement levels as well as learning accuracy.

This paper can be extremely beneficial for other researchers, who intend to explore and inquire into E learning and technological alternatives in education. Also for researchers who aim to keep, high levels of exposure to deal with updated technologies. The framework written in this paper will support researchers, as the material discussed is a great example to deploy in education. This paper also signify the tremendous support the augmented reality can provide for curriculum writers. Because it will suggest necessary changes and updates.

Study limitations:

Human limitation: the study will be on the arts and design students.

Location and place limitations: the study will take place in the faculty of arts and design at the University of Jordan.

Time limitation: the study will happen during the first semester of the academic year (2021/2020).

Subject limitations: this study will rely on the results of the imaginative test data, and the achievement test for the university arts students, therefore the study results depend on the validity of the tool along its consistency.

Digital interior design:

Digital design is immensely growing, due to its contextual relevance to the technical development across all the sectors, such as scientific, industrial, commerce, education and culture. (Dunleavy&Dede, 2016). Design as a process and an outcome became an inseparable part, and a high necessity to the fields as well as work processes. Meaning, Camera, digital drawing boards, light pen and three-dimensional glasses are essential technologies. These inventions are major turning points in the digital design world. (Drascic&Milgram.2015).

Technology is meant to facilitate design procedures and processes. Therefore, design students find it easy to develop ideas and design concepts (Dunser et.al, 2020). Students will be mindful about the capacity of the software. Because it can offer them possibilities and multiple perspectives. Consequently, this can offer more design solutions. (El Sayed, 2021).

Augmented reality is not limited to treating images digitally; it is an educational tool, an approach to teach also an effective interactive learning strategy. Augmented reality catered for the contemporary needs and expectations. (Fonseca et.al, 2020). From here onwards, digital design became the magic wand, allowing designers to depict their designs before they come to life. Students become more aware of the capacity and possibilities of digital design, in addition, its ability to help them adapt to changes. Subsequently, students will develop their understanding of the surroundings further and enhance their communication skills. The design process refers to the design cycle, which encompasses detailed criteria and rigorous assessment. Ensuring Aesthetical values, function, utility, etc... these criteria determine the failure or success of the design. (Freitas & Compos, 2018).

Students' needs is where the design's significance stems from. Students will innovate and spread their vision when practicing design tools, as design processes facilitate creativity; it also channels students' perspective. (Hirumi, 2020). On the other hand, the researcher had to pin point; Agency and individualism are prerequisites and essential fundamentals of any design. The designer has to express and highlight the technical, functional, expressive, and aesthetical purposes. (Hou et.al, 2020).

The interior design professor has to develop new teaching methods and strategies, emphasizing on maintain a positive learning environment to encourage the students to be more involved. The professor has to communicate various augmented technical strategies in order to accentuate the design artistic value and stress on the ability to communicate the design purpose to the audience and consumers. (Hung, 2019). Such design diversity enabled designers to represent their design outcomes beforehand, in order to determine which design to develop or work on. On the other hand, this option is educational, as it allows the students to explore multiple designs from all over the world.

Exposure always sustains creativity; it helps stimulate students' imagination, encouraging them to be principled and responsible towards their designs. Students must understand that duplicating or mimicking global designs is an academic honesty crime. Moreover, the professors must communicate to students the consequences of such acts. Professors must also highlight the significance of reciprocating experiences and referencing designs to the original designer.

Because diverse designs exist abundantly, the design process became easy and facilitated, all because of the multiple design references, not only that but also the designers can share and reciprocate their experience on media platforms for publicity and educational purposes. Augmented reality can astonish the spectator due to the possibilities it offers. This technology has added a new perspective for designers to consider. The upcoming designers can learn more about the mediums, the raw material and all the technicalities needed. This will let the students explore their designs on so many levels, they will note the problems and solve them before sharing the design, and they will have the opportunity to represent and express their ideas. (Johnson, ET, al 2018).

Augmented reality served another educational purpose, which is documenting the design processes and turning it into a learning video tutorial. It helped designers' breakdown the design steps. This learning possibility spread across the globe and reached unlimited number of global citizens teaching them how to design. (Kaufmann, 2016).

Interior Design software programs have to grow and develop alongside the growth of new technological devices and gadgets, such as smart phones. This is a pivotal point to consider, as it is a necessity and a form of adaptation to all the new updates. Such development strategy will help designer attain new tools and perhaps new options. For example urban design, commercials, and animation. (Kerawalla ET. Al, 2017).

Technological expansion provided a completely new platform for shopping options, and e commerce. This has also proven its effectivity across numerous sectors such as; industrial, educational, and commercial. Therefore, global companies such as Facebook, Google, and Amazon invested in such applications, particularly (VR – virtual reality). (Kipper&Rampolla, 2018).

Virtual reality is the computer-generated environment; it can be a mimic or a simulation of a three-dimensional setting of an image, allowing the consumer or the client to interact with in a seemingly real or physical way. Utilizing special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors. It aims to engage the persons' senses of perception in order to live the experience from 360 angle. (Kose&Deperlioglu, 2019). Virtual reality and augmented reality, both technologies connected the world we know with a virtual one through commercials and design. It all became more tangible when people started to interact with the features of the virtual reality and provided feedback for the designers to consider and enhance. On the other hand, people started to download applications with virtual reality features on their laptops, and smart phones to stay connected. Applications such as Go Pokémon and IKEA, which associated virtual reality with commercial and shopping purposes. (Larsen et.al, 2016).

Digital technology is influential; it can change notions, concepts and ideas, which result in perspective change. Visual effects are highly dominant and can easily steel and steer people's attention. This emphasized on the concept; "the power of the image" inviting the spectator to partake and perceive the image differently. (Lawson&Stackole, 2017).

Aesthetical values are key factors for designers, as the outcomes must reflect balanced, harmonized Interior design. Designers follow the arts elements and principles of design to achieve the intended. The design must go under a design school and an art movement to identify its style as well as the philosophy it reflects. This will determine the interaction level with the audience. This is extremely crucial because the designer must create a mindful dialogue with the spectator to fulfill the demands required. (Minn Lee, 2020).

The main objective of the design process is to mimic the reality and allow the consumer to interact directly with it. (Lvanova&Lvanov, 2019). Nevertheless, social media platforms offered fast publicity to speed up the customer's involvement process. Still, the success or failure of the commercial or the advertisement is relevant to the level of interaction. Besides, giving the consumer the option to call, or send messages facilitated communication at any time or pace. (Mackay, 2016).

The national education found high interest in involving digital design within the curricula since the beginning of the third millennium. This facilitated communication, as the students became more familiar on how to use computers, and such software. The ministry of education was aware of the need to involve digital technology in education despite the challenges the local schools were addressed about the significance of technology in order for the upcoming generations to learn and adapt. (Milgram&Kishino, 2017).

Connecting digital technology to education will allow the students to interact through technology across multiple platforms, for effective communication. This might result in new marketing strategies, marketing skills, and new applications to be released.

Students on the other hand, must be fully equipped to adapt and thrive in unfamiliar situations. They must be aware that postmodern design is the ultimate means to compete, to survive, and to create creative designs. Nevertheless, the local market welcomes investors to invest in interior design companies, as they will need local calibers to fulfill designers' roles. (Milgram et.al, 2018).

Augmented reality:

Is a contemporary technology that overlays or superimposes a computer-generated image on a user's view of the world, thus providing a composite or a complex view. Three-dimensional forms are generated for the spectator to interact with. Augmented reality technology exist on people's personal phones and laptops, particularly when the consumer download the application, which works within Android system. Or "IOS". Once the application is set and ready to activate.

The person has to turn on the device's camera in order to the application to turn all the features on the scene into augmented reality. (Owen et.al, 2020). Augmented reality is one of the means to that helped people combine the actual reality and the virtual reality. In the near future, it will be hard to differentiate between reality and virtual reality. (Perez-Lopez&Contero, 2019).

Augmented reality offers image control and the ability to associate virtual and augmented realities. For instance if the professor is guiding the students during class on how to utilize this technical aspect, certain pieces of information has to be available to help them develop the design. Education became easy and more flexible for students to handle. Nevertheless, such software used to belong exclusively to design companies. Later on and due to the consumer needs, it spread across the market, consequently, individuals started to buy them. Now the software exists widely in smart phones, and personal computers. (Radu, 2017).

Augmented reality types:

Location:

Utilizing digital media. Through smart phones, and personal computers. Location feature is accessible “GPS”. This feature provides the consumer with diverse kinds of data “written, imagery, sound messages and three dimensional videos.

Vision:

Depending on the images taken by means of the smart device or smart phone, (R.Q) this feature provides relevant information. (Schrier, 2016).

Augmented reality manifests the ability to blend and combine the reality and the virtual realities, offering interactive nature. It also known for the correctness and information accuracy. On the other hand, data entry is also facilitated. The opportunity for the vital interaction to happen between the teacher and the student is happening at its best. Facilitating learning and teaching through digital mediums, accommodated for the students’ needs. Now every student can learn at their own pace. Besides, augmented reality software became affordable for all the social slices to buy. (Shelton& Hedley, 2018).

When designers or students intend to develop a design, they initially start implementing the design cycle alongside the data and information they assembled. Then they develop their design from a sketch to an actual prototype or a model to propose the concept. Utilizing the tools used in the software to avoid mistakes. As augmented reality, reveals design mistakes in early stages of the design process, therefore, the designer would stop to reflect and reconsider. This feature can encourage designers to take risks and consider creative designs so augmented reality software would validate the design and represent it mistakes-free.

Augmented reality software and programs went beyond imagination, as it offers the ability to trace mistakes or add details through (AR) application via Android devices. To encourage more interaction between AR and VR “2D or 3D” worlds. (Shelton, 2017).

The application (Artivive):

It is an augmented reality platform utilized for art and artistic purposes. This technology facilitates visual manipulation, as artists can suggest new dimensions of art by connecting classical with digital art. This paves the path for more possibilities and more opportunities for designers to produce creative designs. Some might say that this application forms as a time capsule, as artists can take the audience in journey across history and help them understand the artistic experience on a completely new level. Such applications can also reveal the process of the art making, so the audience can have a better understanding of the steps, and phases of the artwork.

Nevertheless, this application spread across the globe, and helped a number of artists exhibit and communicate with more audiences. In order for the application to serve more institutes and more people, it offered an innovative and original digital method for the audience to use when they are in an art gallery or a museum. All what the audience have to do is to activate the application on their smart phones and enjoy the experience. Artivive is an extremely valuable asset, it is dependable, scalable and designers can easily utilize the tools to enhance their designs and artistic creations. Another point to mention regarding this application is its emotional evocation and involvement. Furthermore, it came to the experts’ notice that audience become more interesting in the artwork and that they want to spend more time around it.

An example:

Augmented reality experience happened in Albertina museum in Vienna exhibiting “Stills Film” and combining the two showcases Monet’s and Picasso’s, “The Batliner Collections” alongside the Belvedere museum, which is also in Vienna. (Sumadio&Rambli, 2019).



Figure (1) Artivive “the augmented reality application”
<https://artivive.com>

Academic Digital applications:

These applications can help the arts and design professors and students. This application facilitates the implementation of augmented reality in the classroom. This is a terrific opportunity for the students to develop their skills and imaginative thinking behavior during the class time and under the supervision of the professors. (Wang, 2018).



Figure (2): implementing augmented reality approach on interior design
<https://www.youtube.com/watch?v=8zgmA9NmECU>

Book display:

This approach is easy and enjoyable, as the teacher or student record a brief about the book studied, then the recording transfers to a digital card (Information digital assigned). This process happens through the digital application. This card is glued on the book cover. The student has to scan the card on his smart phone screen. (Wang et. Al, 2020).



Figure (3): interior design application demonstrating augmented reality technology.
<https://www.youtube.com/watch?v=8zgmA9NmECU>

Live photo album:

Augmented reality is highly used in the live photo album. This amazing technology has helped the students learn more about augmented reality and image manipulation and movement. The professors at the faculty of arts and design taught and implemented this feature in one of the arts and design subjects. Particularly, the geometrical drawing class alongside the visual activities suggested in the lesson plans. The great part of the process is that the students can use their smart phones and access more information about the subject studied in hand. (Yuen et.al,2020).

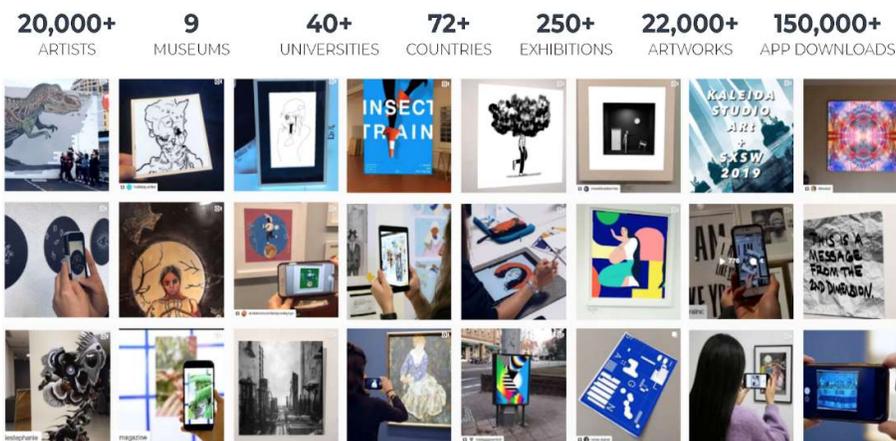


Figure (4): interior design application demonstrating augmented reality technology.
<https://artsdesign.berkeley.edu/artivive>

Display of Safety protocols:

Cards are manufactured with codes of safety and “signs” on them; these cards are hanged across the walls of the faculty of arts and design. The students have to swipe or scan their smart phones screens across the card in order for it to activate and display the needed information and the safety protocols for the students to follow. (Anderson&Elloumi, 2017).

How does augmented reality work?

Augmented reality depends on the program’s ability to define the connections between the real worlds’ elements, and features and match these elements with the virtual reality. Referring to the data indicated about the item, the figure, the place, or any piece of information that can help the user get a better understanding of this transference. (Barreira ET, al, 2019). Furthermore, augmented reality does not only depend on the application, it

also depends on the smart phone and the laptop cameras. The camera helps and aids the program to visually analyze, blend and merge the visual elements according to the users' requirements. Consequently, augmented reality practices support the students' imaginative thinking behaviors and will very much likely develop their creative thinking skills. (Bogen et. Al, 2016).

Imaginative thinking

To be imaginative is to be inventive and original.

Thinking in new ways is the result of constant exposure and experience. Imagination is also a way of knowing and not just in the arts but also across other fields.

In the educational field for example, imagination is highly significant, as it is important to embed it in the teaching and learning approaches. Academic and scientific Studies have emphasized on the importance to deploy imagination across all the academic disciplines. (Chang.et, al, 2017).

Imaginative thinking responds to our senses of perception, we possess the mental ability to store images in our memory and connect them. Some might be able to represent these mental images and creatively create new ones. (Drascic&Milgram, 2015).

Imaginative thinking encompasses three sides to consider. Firstly, the ability to imagine and explore original new ideas. Secondly, the ability to transfer the unfamiliar or the abstract concepts to reality. Some researchers called this process "generating". (Fonseca et. Al, 2020). Thirdly, the perceptual imagination, this aspect specifies the high mental abilities, which acknowledge phenomenal signs and deploy common sense, emotions, and logical dialectic. On the other hand, it supports and serves the first two sides – mentioned above- (Freitas&Compos, 2018).

A number of academic and scientific studies delved into imaginative thinking and its impact on the students' performance (Owen et.al, 2020). Investigating the effects of creativity and imagination on design students' academic achievement in the faculty of arts and design.

Researchers designed a criterion to test and assess the creative and imaginative skills on a (271) students as a sample. From four different universities. This study showed that perceptual imagination acted as mediator between creativity, imagination and academic performance. The study also showed that the first type of imagination – the ability to explore - and transference both had an indirect positive impact on the students' academic performance.

Additionally, Wang and others (Wang et.al.2020) study aimed to examine and determine imaginative nature and all its relevant indicators. Implying that there are two dimensions for imagination including 10 indicators. The first dimension "creative imagination" which includes (intuition, sensitivity, productivity, exploration, renovation). While the second dimension "generated imagination" which includes effectivity, focus, transference, and dialectic argument.

Observation is one of the key qualities the imaginative people possess. They also tend to pay attention to details and read life situations. Connecting facts and images to deduce results and conclusions. Imaginative people tend to be mindful deep thinkers, who are solution focused and mission driven. They have the ability to deploy a memorable image in multiple imaginative scenarios even if there was not a clear connection, they can create one through generating movement and changing the location of the image elements. (Hirumi, 2020).

Imaginative thinking has a positive impact on the teaching process. Radu study aimed to explore the extent of a program effectivity in developing imaginative thinking behaviors. Utilizing a (60) high school students – grade eleven- as a sample, then dividing them to three groups. Controlled group, experimental group (1), which implemented online and internet interactive activities, and experimental group (2), which implemented manual activities. The results of this study showed that the program had an effect on activating and motivating imaginative thinking especially, the first experimental group.

The relationship between imaginative thinking and augmented reality

In order for the students to develop high imaginative thinking skills, they must develop their perception of reality and extend it beyond the image they see. Professors believe that imaginative thinking skills develop when students practice them more often. Practice will offer unfamiliar situations for the students to handle and develop new thinking approaches. Intuition, insight and awareness grow alongside the skill resulting in mindfulness and deep thinking. Imaginative thinking is exceptionally important for the students to explore and develop in their own ways to individualize their design. The researcher concluded that augmented reality supports the students understanding, and serves as an educational tool for better results.

Methodology:

The study in hand followed the descriptive approach in research, delving in augmented reality and imaginative thinking development. The researcher utilized quasi- experimental method to assess the impact of augmented reality tools and techniques on the imaginative thinking routines of the arts and interior design students, and its relation to the accuracy in learning and achievement level, due to its appropriateness to the nature of the study. Utilizing two groups as samples; the experimental group, which received imaginative thinking content, and

went through the assessment. In addition, the controlled group, which received traditional education, bearing in mind the pre and posttest assessments.

The study sample and community:

The members of the controlled and experimental groups are intentionally selected from the faculty of arts and design in the University of Jordan. Therefore, the researcher can monitor and follow up on the progress of the research process. Besides, the availability of the material needed to complete this research. The intended study sample contained (40) students. A random selection took place across both groups “the controlled and the experimented”. The experimental group which contained (22) student, who received augmented reality content. The controlled group, which contained (18) students who received ordinary educational methods. Both groups were put to pre and post assessment. The experimental group will receive education according to the study tools then a post assessment will take place on both groups.

Study tool:

In order for the researcher to assess and evaluate the impact of augmented reality tools and techniques on the imaginative thinking routines of the arts and interior design students, and its relation to the accuracy in learning and achievement level. Two study tools exist in this study:

Criterion 1: assessing imaginative thinking skills and levels, divided into three parts:

- a) Freehand drawing, encompassing ten paragraphs, allowing the student to imagine an idea, or image, or form, or shapes, or the place as mentioned in the geometrical drawing lesson plan, (102) as the student will express in both methods –manually and electronically-.
- b) Cognitive performance, encompassing ten paragraphs, allowing the student to openly answer and respond to paragraphs in multiple forms and technicalities, including the augmented reality methods via ARTivive, and AutoCAD.
- c) Technical movement performance, encompassing four activities, which stem from the application. This allows the student to express the answers by generating mental images, presenting three dimensional mediums and models to communicate the design.

The researcher is aware of the nature of geometrical drawing lessons content as it is rich in imagery, consequently, utilizing the content of the discipline “geometrical drawing” to design the test was appropriate and fair.

Validity and credibility of the tool:

In order to achieve the apparent validity of the study tool, the researcher exhibited the tool across a number of arbitrators to assess and provide feedback. The arbitrators are professors of arts and design. The arbitrators emphasized and selected certain paragraphs, then provided notes and feedback. However, all the amendments took place.

Consistency of the imaginative thinking scale:

In order for the researcher to validate the scale, a pilot study was conducted. Excluding the study samples. It contained (30) students of the faculty of arts and design. Fourteen days later the test took place again, to determine the necessary amendments. According to the pilot study results, the credibility of the scale was determined. Calculating the Cronbach’s correlation coefficient for all the imaginative thinking possibilities. Demonstrated in table (1).

Table (1) stability coefficient values for imaginative thinking test axes and overall scale score

Axes	Correlation Coefficient	Split half
Freehand drawing	0.88	0.930-0.847
Cognitive performance	0.795	0.840-0.749
Technical performance and movement	0.911	0.958-0.876
Total percentage	0.819	0.870-0.785

** Importance level function ($\alpha \leq 0.05$)

Achievement test: this test aims to measure the cognitive aspect in the geometrical drawing class for the students included in the sample. Then the researcher analyzed the content to be able to develop the test questions and the appropriate approach. Consequently, the test showed two types of questions, first: 15 right or false questions, and the second: 15 multiple-choice questions. This test is an attempt to cover the required knowledge,

topics, and measurement levels.

Validity of the achievement test: in order to check and verify the apparent honesty in regards of the content and its appropriateness. The researchers represented the study tool across arbitrators and experts in arts, design, artificial intelligence, and e learning. They provided their opinions, notes and feedback. Amendments tool place.

Consistency of the achievement test: to ensure the stability of the achievement test, the researcher implemented it on a pilot study excluding the original samples of this study. The pilot sample was limited to (33) students from the faculty of arts and design. The 33 students took the test again after fourteen days in order to monitor the scores. According to the outcomes, the researcher will do the necessary amendments. Pin pointing that Pearson (Coefficient) was calculated and the net value was (0.89). Which is acceptable.

Study model:

EG O1 X O1

CG O1 - O1

Symbols meaning:

EG: the experimental group.

CG: the controlled group

OI: social values scale (pre and post)

X: experimental treatment (social theory in education and the ordinary teaching methods).

The ordinary teaching methods.

Data statistical processing:

The researcher utilized (SPSS) to test the four hypothesis.

- Implementing one-way analysis of variance to reveal the compatibility among the groups, calculating the significance differences among the group in reference to the measurement tools.
- Wilcoxon Signed Rank test for small samples.
- Eta square to determine the impact of the independent variable.
- Cronbach's correlation coefficient and Pearson to calculate the binary correlation coefficients.

Groups Pre –test

The researcher implemented pretests, which included imaginative thinking criteria, and achievement test. This happened across each sample member individually. This procedure took place to ensure the compatibility across the groups. Utilizing one-way analysis of variance to determine if there was any significant difference among the students' averages across the study variables (imaginative thinking growth and development, achievement increase, accuracy in learning). The table below demonstrates the results.

Table (2) the results of one-way analysis of variance in the pre- application of the study tools

Variable	Source	Freedom Degree	Sum of squares	Average of squares	Value F	Significance
Imaginative thinking	Across the groups	7	47.131	6.730	3.274	Not indicated
	Among the groups	12	24.665	2.053		
	Total	19	71.798			
Achievement	Across the groups	2	4.802	2.403	4.853	Not indicated
	Among the groups	17	8.405	0.497		
	Total	19	13.204			
Accuracy in learning	Across the groups	2	0.105	0.051	4.856	Not indicated
	Among the groups	17	0.187	0.014		
	Total	19	0.295			

Table (2) demonstrates no differences between the controlled and experimental groups in the imaginative thinking, the achievement test, and accuracy in learning results. The value of (F) in the imaginative thinking test

(3.274) and it is not showing any significant difference at the value ($\alpha \leq 0.05$). In regards to achievement and accuracy in learning, the value (F) is also not significant. This indicates the compatibility of both groups – controlled and experimental- across the study variables pre-application.

Basic Experiment procedures

The researcher applied the experimental treatment and utilized augmented reality techniques. This occurred weekly for three hours, consecutively across two months. Then the post-applied test took place (imaginative thinking, the achievement test). The researcher implemented the test individually across the sample members.

Study results:

Assembling and analyzing data was processed using the statistical methods such as (arithmetic average, standard deviation, and one-way analytical variance) to calculate the statistical differences across the averages. Here under the demonstration of the results:

The results of the study first question:

What is the impact of augmented reality tools and techniques on the imaginative thinking routines of the arts and interior design students in the University of Jordan, and its relation to the accuracy in learning and achievement level? Four hypotheses sprouted and the researchers validated the results as follows:

Firstly, testing the first hypothesis, which clearly indicates no statistical significant differences at the level ($\alpha \leq 0.05$) between both groups – controlled, and experimental group - when they took the posttest. Table (3) demonstrates the results.

Table (3): The significance of the differences between the scores of the students' groups (controlled and experimental) utilizing the affectivity Wilcoxon Signed Rank test.

variable	group	Number	Ranks average	total of ranks	Value of (Z)	Indication level	Eta Square (η^2)	Level/degree
Freehand drawing	Controlled	20	1.47	1.47	-3.937	Indication level at $\alpha \leq 0.05$	0.731	large
	Experimental		10.94	208.45				
Cognitive performance	Controlled	20	1.47	1.47	-3.935	Indication level at $\alpha \leq 0.05$	0.642	Large
	Experimental		10.94	208.45				
Technical performance and movement	Controlled	20	1.47	1.47	-3.878	Indication level at $\alpha \leq 0.05$	0.529	large
	Experimental		10.94	208.45				
Total percentage	Controlled	20	1.47	1.47	-3.926	Indication level at $\alpha \leq 0.05$	0.811	large
	Experimental		10.94	208.45				

Table (3) demonstrates the high positive impact of augmented reality on developing imaginative thinking behavior, as (Z) value reached in total (-3.926) this indicates that it is at the level ($\alpha \leq 0.05$). In order to confirm the previous results, the researcher calculated the adjusted gain ratio, and table (4) demonstrates this:

Table (4): arithmetic mean and standard deviation and the adjusted gain ratio for the “controlled and experimental” groups for the imaginative thinking posttest. (N= 20)

Variable	Group	Arithmetic average	Standard Deviation	Gain Ratio
Freehand drawing	Controlled	19.63	1.75	1.7
	Experimental	26.42	1.70	
Cognitive performance	Controlled	11.2	1.1	1.6
	Experimental	16.59	1.06	
Technical performance and movement	Controlled	8.94	1.86	1.5
	Experimental	12.57	1.24	
Total percentage	Controlled	39.57	2.64	1.6
	Experimental	55.56	2.95	

Table (4) demonstrates the effect of augmented reality on imaginative thinking behavior for the experimental group, through the difference in the average levels across the controlled and experimented group, reaching (16.01), indicating a wide difference between both of them. The value of the adjusted gain ration (Black) (1.6) and it is higher than (1.2) that was determined by the adjusted gain ratio black, accordingly, the null (0) hypothesis is rejected and the alternative hypothesis is accepted in favor for the experimental group.

Secondly, testing the second hypothesis which indicates that there are no statistical significant difference at the level ($\alpha \leq 0.05$), among the grades average across the arts and design students in both groups (controlled and experimental). –The experimental received the augmented reality lesson plan, while the controlled received ordinary education methods - , on the posttest results and table (5) demonstrates the results:

Table (5) the significance of the differences between the mean scores of the students’ group (controlled and experimental) using the potency ratio Wilcoxon Signed Rank test for achievement.

The group	Number	Level average	Sum of level	Z value	Statistical significance	Eta square	degree
Controlled	20	1.47	1.47	- 3.949	Statistical significance at the level ($\alpha \leq 0.05$).	(η^2)	Large
Experimental	20	10.94	208.45			0.594	

Table (5) the augmented reality has an enormous positive impact on the achievement levels. Z value reached the total of (-3.949) this indicates that it is significant at the level ($\alpha \leq 0.05$). In order to confirm the previous results the researcher calculated the adjusted gain ratio and table (6) clarifies the following:

Table (6): Arithmetic mean and standard deviation and the adjusted gain ratio for the “controlled and experimental” groups for the achievement posttest. (N= 20)

The group	Arithmetic average	Standard deviation	Gain ratio
Controlled	13.11	1.33	1.5
Experimental	19.52	0.226	

Table (6) demonstrated the impact of augmented reality techniques on the students’ achievement levels, by the difference in the mean scores of the control and experimental group, which is (6.41), this indicates a big difference between both groups. The adjusted gain ratio (black) (1.6) and it is higher than (1.2) determined by the adjusted gain ratio, accordingly, null theory is rejected and the alternative theory is accepted in favor for the experimental group.

Thirdly, testing the validity of the third hypothesis, briefly, it indicates that there are no statistical significant difference at the level ($\alpha \leq 0.05$). Between the average scores of the two groups (experimental which received augmented reality content and the controlled group which received ordinary education), in the posttest of the learning accuracy for the faculty of arts and design students at the university of Jordan and table (7) demonstrates the results.

Table (7): significance of differences between the mean scores of the students of the control and experimental group using the effectiveness ratio Wilcoxon Signed Rank test

The group	Number	Level average	Sum of levels	Z value	Statistical significance	Eta square (η^2)	degree
Controlled	20	1.47	1.47	-3.866	Statistical significance At the level ($\alpha \leq 0.05$).	0.664	large
Experimental	20	10.94	208.45				

Table (7) demonstrates the high and positive affect of augmented reality on the accuracy of learning as the value of Z reached (3.866). Which is at the level ($\alpha \leq 0.05$). In order to confirm the previous results, the researcher calculated the adjusted gain ration, and table (8) demonstrates the following:

Table (8): the arithmetic average, the standard deviation, and the adjusted gain ratio for both groups in achievement posttest. (N=20)

The group	Arithmetic average	Standard deviation	Gain ratio
Controlled	0.252	0.331	1.5
Experimental	0.944	0.104	

Table (8) demonstrates the effect of augmented reality techniques on students learning accuracy in the experimental group, by difference in the average score of (0.708). This indicates a high difference. The adjusted gain ratio (black) (1.5) and it is higher than (1.2) determined by the gain black, accordingly the null (0) hypothesis is rejected and the alternative hypothesis is accepted in favor for the experimental group.

Fourthly, confirming that the fourth hypothesis is valid, which stresses that there is no correlation between developing imaginative thinking, and achievement level and learning accuracy for the arts and design students at the University of Jordan. In order to ensure and confirm the hypothesis the researcher utilized Pearson correlation coefficient to calculate the binary correlation coefficients among the students' grades between imaginative thinking, an achievement level posttest as well as learning accuracy levels. Table (9) demonstrates the results:

Table (9): values and semantics of the correlation coefficients between imaginative thinking, achievement level and learning accuracy in the experimental group (N=20)

Correlation coefficients	Imaginative thinking	Achievement level
Achievement level	not significant 0.123	
Learning accuracy	not significant 0.123	Significance at 940-0.01

Table (9) demonstrates that the binary correlation coefficient among the posttest process for the imaginative thinking, achievement level and the learning accuracy in the experimental group are all not statistically significant at the level 4840. On the other hand, there is a correlation between the posttest of the achievement level and the learning accuracy for the students in the experimental group. Accordingly, the null hypothesis is rejected and the alternative hypothesis is accepted. Therefore, the researcher concluded that there is a correlation between high achievement level and learning accuracy – in the experimental group- indicated in the posttest.

Discussing results

After reviewing the study results, the researcher discussed them as follows:

Firstly, discussing the results of the first hypothesis

According to the previous statistical calculations and reviewing the results, the researcher deduced that perhaps the success of the experimental group in developing the three dimensions of the imaginative thinking. This is justified as the group went through changes in educational approaches and multiple intersecting factors, some are tangible and some are not, which was directly connected to the augmented reality tools and techniques depending on the moving image. This technology had enormous positive affect on the experimental group during the geometrical drawing class. This technology depended on utilizing the augmented reality programs to change the designed image into a three dimensional, interactive and moving image.



The images above, demonstrate the students' outcomes during the academic semester. These are the controlled group outcomes utilizing regular computerized programs while the experimental group used the same images and resulted in moving ones. The experimental group was exposed to multiple mind provoking and movement exercises. This educational approach supported the students own development and enhanced imaginative thinking behaviors it made it easy for them to implement and communicate their imagination. Because of augmented reality programs, the students become more aware of the design details and problems before communicating and implementing it. At this point, the students can define the problem and solve it, therefore, they can save time and effort, this option was not available before. On the other hand, the controlled group did not encounter the same situation, they had a very different learning experience where the images are still and were not treated.

Accordingly, the researcher referred to previous supporting studies and depending on the results, she was encouraged to inquire more about the imaginative thinking behaviors via technology. For example (Shelton&Hedley, 2018). Their study utilized the Nano technology. This agrees with the study in hand, as it discusses the effect of augmented reality on stirring and motivating imaginative thinking. However, (Kerawalla et.al, 2017). Utilized a program in Graph theory, the results showed that modern technology has no significant effect on motivating imagination because it is hard to implement it across all subjects.

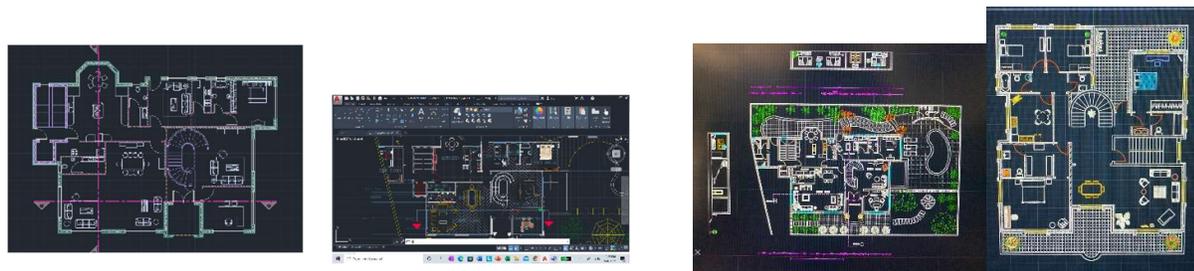
Secondly, discussing the results of the first hypothesis

The results indicate that utilizing augmented reality techniques in teaching were fruitful and rewarding on both practical and academic aspects. The program upgraded the learning experience, as the nature of the content has hanged to cater to the students' needs and evoke their senses of perception. This will result in high achievement.

Augmented reality exhibited adjustment tools; and showed the students how to deploy them when they design. The program represented designs and suggested solution. Another advantage of the program, it offers multiple solution scenarios for the students to learn from, through videos and tutorials. This option aligned with the students' perception and interactive ability. Particularly when the students became aware of the programs' advantages, options and facilities, they can save time and effort. This scaffolding process adds value to their understanding and progress. On the other hand, the traditional teaching approach took double the time, besides; the design is more likely to result in mistakes and problems.

As this is evident in the students' work as demonstrated below:

The experimental group treated the image with augmented reality tools and techniques, while the controlled group did not implement advanced techniques, therefore the images are still.



The researcher was keen on studying and examining the previous studies, which can provide material and support the current study, however, she apprehended that the studies were limited. Therefore, she depended on (Hou.et.al.2020) study, as it is parallel to its objectives and it exhibited how augmented reality affects the students' achievement. Yet, (Yuen.et.al.2020) study, which stressed on the importance to include an experienced mentor or a teacher in the teaching process for guidance and feedback. However, this is a costly option and it is time consuming. In addition, it does not cater to all the subjects; therefore, it does not correlate with the students' achievement level.

Thirdly, discussing the results of the third hypothesis

Perhaps the students – the experimental group - succeeded in the learning experience because they were able to study the videos and tutorials carefully and they took time to comprehend the tools and techniques the program provide. Augmented reality adds value to the learning strategies as the student now can deploy the features and elements of the program, which affected the positivity and kept the students motivated towards learning. This will always have a significant affect, especially in learning accurately, as students will experience and learn as they develop their designs. On the other hand, the controlled group did not receive detailed feedback; therefore, their outcomes were not as successful.

Fourthly, discussing the results of the fourth hypothesis

The results indicate that there is a correlation between the achievement results of the posttest and the learning accuracy across the discipline (Geometric drawing), as augmented reality program affected the results positively and the students achieved high scores. This communicates that the experimental group students highly benefited from augmented reality programs. There is also a correlation between imaginative thinking and improving achievement levels as well as learning accuracy. Students must be exposed to international and local examples, to develop their imaginative thinking routine; and steer their ability to develop an original design. This will have a direct impact on the learning accuracy.

Conclusion

It is highly evident that digital worlds are growing, rapidly changing and becoming more influential by the hour. Despite the fact that elements of art and the principles of design are intact and acknowledged, the augmented reality deployed them innovatively and introduced new means to design, nevertheless, problem solving.

Design as a discipline and as a process demand new visions, new means to facilitate communication and cater to the renewed customer needs. Augmented reality is a needed mutation in the design world, as it supported creativity and offered exposure. Designers now have to develop imaginative thinking behaviors to parallel their concepts and ideas to such programs and test the possibility to build and communicate them impeccably. Researchers agreed that augmented reality is a beneficial platform for the students to upgrade their ideas and impress their audience.

Recommendations

According to the statistical results and the researchers' research journey, augmented reality is highly recommended. It adds a great value to the teaching methods and pedagogical strategies in teaching and learning. Keeping in mind that augmented reality provides the students with embedded guidance as the efforts are channeled and guided across the design process. This option will always save them time. It positively affected imaginative thinking, besides, it motivated the students to learn and develop their skills. The researcher advise the faculty to provide professional development workshops and train the professors on the latest programs in order to cope with the changes. The researcher also encourage professors to develop similar studies examine more means and methods for better education. Because developing teaching methods motivate students to attain new skills or develop the ones they have. Lastly, the researcher advice professors to produce purposeful comparative studies, delving into augmented reality and virtual reality.

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