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# The Impact of Metaverse Affecting Factors on Learning Effectiveness: A Case Study

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## ABSTRACT

The main purpose of this study is to analyse the effect of metaverse certain factors on learning effectiveness via metaverse utilization. The population for this study consists of academic staff at the police college-Abu Dhabi. A simple random sampling technique was used to select the respondents surveyed for this study, a total of 80 questionnaires were administered to respondents; statistical tools were used to test the hypothesis such as: one way ANOVA and simple regression. The findings indicated that there were no significant differences in the perception of respondents toward the utilization of metaverse on student learning effectiveness. The study also showed that the overall of metaverse affecting factors has a significant impact on learning effectiveness, further study results have been revealed and discussed.

**Keywords**: metaverse, affecting factors, learning effectiveness

## INTRODUCTION

The metaverse discovery is contributing in shifting the whole life aspects, it pushes toward widening its use in daily life; the way people communicate as several technological applications are integrated and new Internet applications have also developed. From the user's point of view, the demands on the freedom of the virtual world, the content and interaction methods of the Internet, etc. are constantly increasing.

No doubt that metaverse is composed of four areas: immersive realism, ubiquity of access and identity, interoperability, and scalability. Metaverse is recognized as an evolving paradigm of the next-generation Internet after the web and the mobile Internet revolutions (Grider & Maximo, 2021).

Focusing on the field of teaching, metaverse is an important teaching field that us using artificial intelligence, virtual reality and other technologies to provide teachers and learners with a virtual teaching interactive environment; it is a response to the "New Generation Artificial Intelligence Development Plan" issued by the State Council in 2017. Development Plan" issued by the State Council in 2017. It is an important way to "establish a learner learner-centered educational environment, provide accurate push education services, and realize the customization of daily education and lifelong education"; it is the further development of modern teaching, and the development of virtual reality intelligent modelling, group Intelligence, cross cross-media analysis and reasoning, and hybrid augmented intelligence teaching are new trends that make breakthroughs in traditional teaching in terms of environment, concepts, and methods; it is also an exploration made in an attempt to solve the problems occur in the online teaching during the pandemic. The main purpose of this paper is to the reveal the importance utilization of metaverse on learning and highlight the possible factors affecting learning process through using Metaverse.20 (Liu, 2022).

## THEORETICAL FRAMEWORK

### Metaverse Concept and Exploitation

The original concept of the metaverse comes from the 1992 science fiction novel "Avalanche" by Neil Stephenson, and the first publication about the metaverse on the Web of Science was published in 1998. The development of metaverse is still in its infancy, and its business model is not mature. Due to the open issues such as interaction issues, computing power pressures, ethical constraints, privacy risks, and addiction risks in the different worlds, and the fact that metaverse development is still limited by current technology, research interest in metaverse is at an Ebb Stage after 2013 (Wang et al., 2021).

The novel metaverse differs from the earlier metaverse in three ways. First, the rapid development of deep learning dramatically improves the accuracy of vision and language recognition, and the development of generative models enables a more immersive environment and natural movement (Park & Kim, 2022).

### Metaverse Definition

The word ‘metaverse’ is a portmanteau of the prefix “meta” (meaning “beyond”) and the suffix “verse” (shorthand for “universe”). Thus, it literally means a universe beyond the physical world. More specifically this “universe beyond” refers to a computer-generated world, distinguishing it from metaphysical or spiritual conceptions of domains beyond. In addition, the metaverse refers to a fully immersive three-dimensional digital environment in contrast to the more inclusive concept of cyberspace that reflects the totality of shared online space across all dimensions of representation (Dionisio et al., 2013).

The metaverse integrates a variety of emerging technologies. In particular, digital twin produces a mirror image of the real world, VR and augmented reality (AR) provide immersive 3D experience, 5G and beyond offers ultra-high reliable and ultralow latency connections for massive metaverse devices, wearable sensors and brain-computer interface (BCI) enable user/avatar interaction in the metaverse, artificial intelligence (AI) enables the large-scale metaverse creation and rendering, and blockchain and non-fungible token (NFT) plays an important role in determining authentic rights for metaverse assets (Wang et al., 2022).

### Metaverse Affecting Factors

In this study, four factors have been considered as the affecting factors in the utilization of metaverse in the learning processes, as follows (Dionisio et al., 2013):

(1) Realism. Is the virtual space sufficiently realistic to enable users to feel psychologically and emotionally immersed in the alternative realm?

(2) Ubiquity. Are the virtual spaces that comprise the metaverse accessible through all existing digital devices (from desktops to tablets to mobile devices), and do the user’s virtual identities or collective personal remain intact throughout transitions within the metaverse?

(3) Interoperability. Do the virtual spaces employ standards such that (a) digital assets used in the reconstruction or rendering of virtual environments remain interchangeable across specific implementations and (b) users can move seamlessly between locations without interruption in their immersive experience?

(4) Scalability. Does the server architecture deliver sufficient power to enable massive numbers of users to occupy the metaverse without compromising the efficiency of the system and the experience of the users?

## THE CONCEPTUAL FRAMEWORK AND HYPOTHESIS

### Research Conceptual Framework

This study developed a conceptual framework that consist of two parts: the first part of the framework consisted of metaverse affecting factors as the independent variable (realism, ubiquity, interoperability and scalability) and learning effectiveness as the dependent variable. Figure 1 depicts the study conceptual framework.

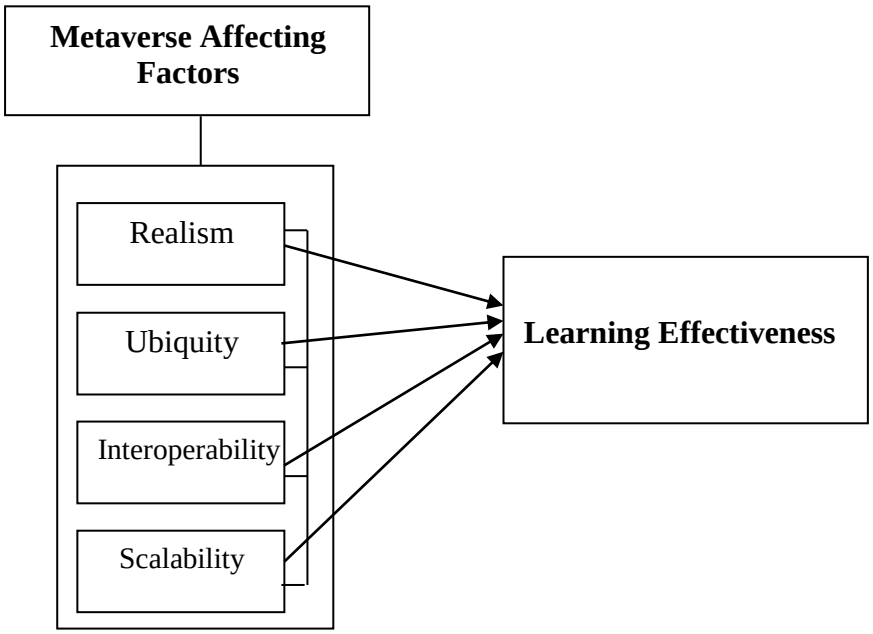


**Figure 1: Research Framework / Study Model**

To examine the utilization of social media on knowledge sharing, the following characteristics will be used for the purpose of this study:

### Research Hypothesis

Based on the conceptual framework and the literature review, research hypothesis formulated as follow:

***Hypothesis 1****:* Research respondents at the police college-Abu Dhabi will differ in their perception toward the utilization of metaverse in the learning process.

***Hypothesis 2****:* There is no significant impact of metaverse affecting factors (realism, ubiquity, interoperability and scalability) on learning effectiveness. This hypothesis is broken into four minor hypotheses:

**$H_0$: 2.a.** There is no significant impact of realism on learning effectiveness.
**$H_0$: 2.b.** There is no significant impact of ubiquity on learning effectiveness.
**$H_0$: 2.c.** There is no significant impact of interoperability on learning effectiveness.
**$H_0$: 2.d.** There is no significant impact of scalability on learning effectiveness.

## LITERATURE REVIEW

Lim (2022) found in his study that there is impact of the metaverse technology on science teaching, including the teaching goals of strengthening scientific concepts, cultivating scientific thinking, encouraging inquiry practice, and clarifying attitude and responsibility; it involves the technical, environmental, and ethical conditions that need to be realized for

science teaching to enter the metaverse field; the actual operation procedures that can be divided into three levels and seven modules; the efficient, continuous, and diverse evaluation of the entire teaching activity, which provides new perspectives for solving the common problems in the current online science teaching and realizing the innovation of science teaching mode, enabling teachers and learners to accept the influence of the progress of science and technology itself in science teaching activities, and to better develop their own scientific literacy through independent inquiry and practice.

Wang et al. (2022) presented in their study an in-depth survey of the fundamentals, security, and privacy of metaverse. Specifically, they have introduced a novel distributed metaverse architecture and discussed its key characteristics, enabling technologies, and modern prototypes. Afterward, the security and privacy threats, as well as the critical challenges in security defenses and privacy preservation, have been investigated under the distributed metaverse architecture. Furthermore, we have reviewed the existing/ potential solutions in designing tailored security and privacy countermeasures for the metaverse. We expect that this survey can shed light on the security and privacy provision in metaverse applications, and inspire more pioneering research in this emerging area.

Kye et al. (2021) concluded in their study the metaverse is predicted to change our daily life and economy beyond the realm of games and entertainment. The metaverse has infinite potential as a new social communication space. The following future tasks are suggested for the educational use of the metaverse: first, teachers should carefully analyse how students understand the metaverse; second, teachers should design classes for students to solve problems or perform projects cooperatively and creatively; third, educational metaverse platforms should be developed that prevent misuse of student data.

Suh and Ahn (2022) found in their study that, on average, 97.9% of elementary school students had experiences with the metaverse, with 95.5% of them considering it closely related to their everyday life. In addition, various conclusions according to each metaverse factor and each participant's gender are provided.

Toto and Limonea (2021) found in their study that educational technologies were expected to profoundly impact curricula and teaching and learning methodologies in the new millennium. Since that study, more than 20 years on, the technologies surrounding our students have been evolving on a daily basis, and the process of including technology within the classroom context is inexhaustible and goes hand in hand with the evolution of technology

The study conducted by Xi et al. (2022) revealed that AR was significantly associated with overall workload, especially mental demand and effort, while VR had no significant effect on any workload sub-dimensions. There was a significant interaction effect between AR and VR on physical demand, effort, and overall workload. The results imply that the resources and cost of operating XR-mediated realities are different and higher than physical reality.

A study by Fu et al. (2019) examined how a productive learning atmosphere can be fruitful in a technology-based environment. The study has concluded that strategies of cooperation within a group of learners and competitions among groups of learners create a better learning environment and a higher level of knowledge-development

The study conducted by Akour et al. (2022) was able to identify the perceived usefulness (PU) to be an essential predictor of the factor of users' intention to use the metaverse system (MS). The fact was discovered during ANN and IPMA analysis. Furthermore, this study is practically significant, as it helped the concerned authorities in educational sector in understanding the significance of each factor and allowed them to make efforts and plans according to the order of significance of factors. Another important implication of the study is methodological in nature. It validates that deep ANN architecture

can offer deep insight into non-linear relationships shared by various factors of a theoretical model.

A study conducted by MacCallum and Parsons (2019, pp. 21–28). The educators were asked to use AR in the classroom to create mobile AR experiences using the metaverse AR tool. The results showed that the teachers were interested in the content rather than the AR tool itself. This questions whether the role of AR as part of metaverse was well-presented to teachers and students to enable them to comprehend the importance of metaverse in their daily classrooms.

## STUDY METHODOLOGY

### Population and Sample

The target population of this study comprised all academic staff at the police college-Abu Dhabi, (80) questionnaires were distributed to them via online; they were all answered and included in the analysis.

### Data Collection

Primary data collection and secondary data collection methods were engaged. The primary data collection was carried out using a self-designed questionnaire. Secondary data was collected based on the findings of prior studies, published papers, articles, books and the World Wide Web (Internet) related to social media and knowledge management and sharing.

### Instrument for Primary Data Collection

A questionnaire survey, which comprises two sections, was adopted to collect the primary data in this study. The first section covers the demographic information (gender, age, education level and academic experience). The second section represents the instrument; there were selected (20) items of metaverse affecting factors and (7) items of learning effectiveness which were developed by the researcher based on the theoretical background and literature review, as follows: (1-20) measures of metaverse affecting factors (realism, ubiquity, interoperability and scalability) were adapted from Dionisio et al. (2013), (21-27) measures of learning effectiveness were adapted from Toto and Limonea (2021), Suh and Ahn (2022), and Lim (2022).

### Validity and Reliability of the Data

***Validity of Data Collected***

To ensure the face validity of the instrument tool, it was given to 4 expert referees, they displayed their constructive comments and suggestions, which were taken into consideration.

***Reliability of Data Collected***

The reliability of data collected was measured using Cronbach alpha coefficient; the reliability test was conducted to check for inter-item correlation of each of the variables in the questionnaire. The test results were as follows: Cronbach alpha for independent variable (metaverse affecting factors) = **0.862**, Cronbach alpha for dependent variable (learning effectiveness) = **0.825**, Cronbach alpha for overall instrument = **0.864**, which exceeded the acceptable limit (Zikmund, 2002).

***Data Analysis***

In order to test the hypothesis, the following tools were used: descriptive analysis frequencies, means and standard deviation were calculated, while to test the hypothesis one way ANOVA was used to measure the differences between groups, and finally multiple regression analysis was calculated to assess the impact of metaverse affecting factors on learning effectiveness among academic staff.

## HYPOTHESIS TESTING

### Test Hypothesis 1

To test whether academic staff at the police college-Abu Dhabi will differ in their perception toward the utilization of metaverse on learning effectiveness, we carried out one-way ANOVA analysis. It was found that ANOVA for the perception is not significant, refer to Table 1 (sum of square between groups = 0.152 with DF=1, F=0.564, P=0.413). Based on this result we reject the null hypothesis 1 and accept the alternative hypothesis: the perception of respondents at the police college does not differ toward the utilization metaverse on learning effectiveness.

**Table 1: ANOVA**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | .152 | 1 | .181 | .564 | .413 |
| Within Groups | 49.826 | 192 | .260 | | |
| Total | 50.006 | 193 | | | |

### Test the Major Hypothesis 2

To test the major hypothesis that there is no significant impact of metaverse affecting factors on learning effectiveness by the academic staff at the police college-Abu Dhabi, the simple regression was carried out. Table 2 depicts the model. It was found encouraging result here. It shows that the value of ($R^2$ = 0.423), this means that metaverse affecting factors were able to explain (423%) of the variance in the dependent variable, it also shows the F value is (f = 44.145) significant at (P≤0.05), in addition the value of Beta (β=0. 643, P≤0.05). Based on the result we reject the null hypothesis 2 and accept the alternative hypothesis indicating that metaverse affecting factors have a significant impact on learning effectiveness by the academic staff at the police college-Abu Dhabi at the level of (P≤0.05).

**Table 2: Regression results: impact of metaverse affecting factors on learning effectiveness**

| Model | R | $R^2$ | Adj. $R^2$ | β | F | T | Sig. |
|---|---|---|---|---|---|---|---|
| Predictor: Over all factors | .661 | .423 | .434 | .643 | 44.145 | 6.155 | .000* |

Note: *Significant level at p≤ 0.05

### Test Minor Hypotheses

***Test Minor Ho: 2.a***

To test the minor hypothesis that there is no significant impact of realism on learning effectiveness, the study carried out the simple regression. Table 3 depicts the model. It shows that the value of ($R^2$ = 0.623), this means that realism was able to explain (623%) of the variance in the dependent variable (learning effectiveness). It also shows the F value is (f = 74.623) significant at the level of (P≤0.05), which means that there is statistical evidence to support the existence of a relationship effect between realism and learning effectiveness. Based on the result we reject the Ho: 2.a and accept the alternative hypothesis that indicates: realism has a significant impact on learning effectiveness at the level of (P≤0.05)

**Table 3: Regression results: impact of realism on learning effectiveness**

| Model | R | $R^2$ | Adj. $R^2$ | β | F | T | Sig. |
|---|---|---|---|---|---|---|---|
| Predictor: Over all factors | .785 | .623 | .608 | .478 | 74.623 | 1.533 | .000* |

Note: *Significant level at p≤ 0.05

***Test minor Ho: 2.b***

To test the minor hypothesis that there is no significant impact of ubiquity on learning effectiveness, the study carried out the simple regression. Table 4 depicts the model. It shows that the value of ($R^2$ = 0.521), this means that ubiquity was able to explain (521%) of the variance in the dependent variable (learning effectiveness). It also shows the F value is (f = 12.135) significant at the level of (P≤0.05), which means that there is statistical evidence to support the existence of a relationship effect between ubiquity and learning effectiveness. Based on the result we reject the Ho: 2.b and accept the alternative hypothesis that indicates: ubiquity has a significant impact on learning effectiveness at the level of (P≤0.05).

**Table 4: Regression results: impact of ubiquity on learning effectiveness**

| Model | R | $R^2$ | Adj. $R^2$ | β | F | T | Sig. |
|---|---|---|---|---|---|---|---|
| Predictor: Over all factors | .667 | .521 | .202 | -.023 | 12.135 | 6.791 | .000* |

Note: *Significant level at p≤ 0.05

***Test Minor Ho: 2.c***

To test the minor hypothesis that there is no significant impact of interoperability on learning effectiveness, the study carried out the simple regression. Table 5 depicts the model. It shows that the value of ($R^2$ = 0.445), this means that interoperability was able to explain (445%) of the variance in the dependent variable (learning effectiveness). It also shows the F value is (f = 18.452) significant at the level of (P≤0.05), which means that there is statistical evidence to support the existence of a relationship effect between interoperability and learning effectiveness. Based on the result we reject the Ho: 2.c and accept the alternative hypothesis that indicates: interoperability has a significant impact on learning effectiveness at the level of (P≤0.05).

**Table 5: Regression results: impact of interoperability on learning effectiveness**

| Model | R | $R^2$ | Adj. $R^2$ | β | F | T | Sig. |
|---|---|---|---|---|---|---|---|
| Predictor: Over all factors | .746 | .445 | .283 | -.073 | 18. 452 | 8.465 | .000* |

Note: *Significant level at p≤ 0.05

***Test minor Ho: 2.d***

To test the minor hypothesis that there is no significant impact of scalability on learning effectiveness, the study carried out the simple regression. Table 6 depicts the model. It shows that the value of ($R^2$ = 0.435), this means that scalability was able to explain (435%) of the variance in the dependent variable (scalability). It also shows the F value is (f = 32.224) significant at the level of (P≤0.05), which means that there is statistical evidence to support the existence of a relationship effect between scalability and learning effectiveness. Based on the result we reject the Ho: 2.d and accept the alternative hypothesis that indicates: scalability has a significant impact on learning effectiveness at the level of (P≤0.05).

**Table 6: Regression results: impact of scalability on learning effectiveness**

| Model | R | $R^2$ | Adj. $R^2$ | β | F | T | Sig. |
|---|---|---|---|---|---|---|---|
| Predictor: Over all factors | .657 | .435 | .417 | .176 | 32. 224 | 4.962 | .000* |

Note: *Significant level at p≤ 0.05

## CONCLUSION AND RECOMMENDATIONS

The findings of this empirical study confirmed the following:

1. The study indicated that there are no differences between respondents at the police college-Abu Dhabi in their perception toward the utilization of metaverse on learning effectiveness.
2. The study revealed that the overall of metaverse affecting factors has a significant impact on learning effectiveness at the level of (P≤0.05).
3. The study showed that there is statistical evidence to support the existence of a relationship effect between realism and learning effectiveness at the level of (P≤0.05).
4. The study revealed that there is statistical evidence to support the existence of a relationship effect between ubiquity and learning effectiveness at the level of (P≤0.05).
5. The study indicated that there is statistical evidence to support the existence of a relationship effect between interoperability and learning effectiveness at the level of (P≤0.05).
6. The study indicated that there is statistical evidence to support the existence of a relationship effect between scalability and learning effectiveness at the level of (P≤0.05).

Based on the study findings, the authors make the following recommendations:

1. Since the study results show that there is no significant difference among the respondents toward the utilization of metaverse on learning, it is though recommended to further create the learning environment to better encourage the learning process effectiveness.
2. It is very important to highlight the affecting factors that limit the effectiveness of learning via the utilization of metaverse in the learning process.
3. It is highly recommended to consider the risks that the metaverse application may pose to ensure the learning effectiveness.
4. To widely and efficiently provide all means to support the learning process via the utilization of metaverse.
5. To continue monitor and gauge the effect use of metaverse tools on learning effectiveness through constantly assessing its performance effectiveness.
6. It is necessary to carry out future studies to widen the scope of the study to further investigate the effect of metaverse on the overall learning environment.

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