COMPARING THE EFFECTIVENESS OF ONLINE AND TRADITIONAL LEARNING IN COMPUTER RELATED FIELDS

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Abstract

The traditional classroom environment is gradually losing its monopoly as the sole setting of learning. Digital learning is becoming an attractive model across the higher education spectrum as new innovative information technologies have become widely available. Online learning is used as a tool that improves learning performance while combating the reduction in resources.

This work presents a novel study focusing on estimating the efficiency of online learning in comparison to traditional learning for computer related fields in education institutions in Albania. A survey is conducted to estimate the impact that the learning modality has on students enrolled in computer technology related fields. The study focuses on measuring the role that intrinsic factors, teaching practices, learning intentions and programming expertise have on the perceived usefulness and the efficacy of online learning.

Measuring the role and effect of the learning modality will be important to estimating whether students and higher level education institutions are ready to shift towards online learning, or to integrate it into the current traditional framework. The results of our study are useful to have a better understanding of the benefits of online learning alongside with the challenges that need to be addressed in order to improve the teaching experience and outcomes.

Keywords: *Online learning, traditional learning, course delivery methodology, blended learning, computer-related fields.*

1. Introduction

The rapid technological revolution of the past decade has increased the popularity of online learning across the higher education spectrum. Digital learning – a cost saving approach that comes with increased learning and teaching flexibility and higher opportunities for students to learn at their own pace – appears convenient and beneficial for students and higher level education institutions.

Recent events, such as the Covid-19 pandemic oblige countries and education institutions to shift towards online learning (Kanwar, 2020) (Morgan, 2020). For learners, convenience of learning alongside the ability to bypass geographical constraints has replaced many of the traditional educational environments and has given them more and greater opportunities to continue their education. The flexibility of learning "*anytime, anywhere*" comes with additional advantages such as convenience, saved time, and increased participation.

Despite the impactful advantages that online learning offers, it is not accepted without criticism. Removing the instructor from the distance and the time dimensions, alongside scattering students in the digital world might cause a sense of loss in terms of the vital context of the learning environment. Decreasing the social interaction makes students less motivated and provides them with fewer opportunities for hands-on experience. Furthermore, technical issues and increased distractions might reduce

the dynamics of in-class engagement.

Examining the inherited advantages and challenges presented with each learning environment is vital to create a common ground of principles that allow learning to thrive. The continuous exchange between the teacher and the student is a crucial component, despite the learning setting. Without it, learning is either greatly hindered or arguably nonexistent.

In an attempt to further refine, explain and compare the importance of physical attachment to a learning environment, this work will focus on a contextual comparative study for Albanian higher level institutions, focused on the field of technology related areas such as computer science and engineering, information technology, or other related fields based on computer programming. The purpose is to measure the effect of key components such as: i) teaching presence, ii) learning satisfaction, iii) learning results alongside with the link and the strength of connection between these components, while considering intrinsic factors, perceived usefulness, teaching practices, learning intentions and programming expertise.

To that end, this paper not only provides a theoretical framework for comparing the effectiveness of online and face-to-face learning for computer technology-related areas, but it supports such claims with data collected from 205 students across several private and public higher education institutions in Albania. A detailed analysis follows.

The rest of this paper is organized as follows. Section 2 provides a review of related work and literature. Section 3 highlights the central research questions that this work aims to address and presents the research used. A thorough analysis of the data is provided in section 4. This report ends with a summarized discussion and recommendations provided in section 5.

2. Literature Review

Extensive research is focused on the role and impact that the learning environmental setting has on results and satisfaction. This work focuses on comparing the effectiveness of online learning methodologies for computer related fields.

Advanced computer literacy is a fundamental skill for the academic and professional world (Lam, 2008). Worldwide statistics show that out of 19,7 million students enrolled at some form of post-secondary institution, 6.6 million students enrolled in online classes to some extent (Bastrikin, 2020), listing personal circumstances as major reasons for their choice.

Another study conducted in Europe on 2015 addressing the choices between different types of learning methodologies such as: face to face, blended, blended/online, face to face/blended/online, face to face/online, online and blank showed that a notable majority of 69.63% of participants preferred traditional (face-to-face) classroom settings. The greatest motivation for pursuing online classes at a rate of 31.27% was that online education is easier to combine with the student's other occupations. (Owusu-Boampong & Holmberg, 2015)

Focusing on computer programming courses, according to a study from West Virginia University, which tested the efficiency and satisfaction from a student's perspective on one online course for first-year engineering students, the author concluded that learning programming online was a difficult task. Also, it was concluded that better platforms and technology will be necessary to maintain the students' engagement and to stimulate better the dynamics created in a real classroom. (Santiago, 2014).

Online programming classes are a novelty not only for students but also for teachers and thus many issues are associated with it even from a teaching perspective. According to a study conducted by researchers from USA and Finland: *"Teaching programming online is an area where experience reports still heavily predominate the literature, indicating that the research still remains in the early stages. Part of the reason may be that many educators have their first teaching experiences in a face-to-face environment. This makes it natural to replicate that experience when creating online courses, which requires using tools to produce the types of interaction seen in the on-site classroom. While approaching teaching programming online as a translation process from existing face-to-face*

experiences is natural, it may be also limited by personal experiences and things that we do not know." (Settle, Vihavainen, & S. Miller, 2014)

Our study focuses locally on the city of Tirana by addressing the role that the learning methodology plays on students' satisfaction in computer related areas. The development of our survey bases some methodological elements of the main factors that contribute to the development of programming skills in e-learning among undergraduate students on the work of (Rafique, Dou, Hussain, & Ahmed, 2020).

The authors propose that programming education should follow the Technology Acceptance Model (TAM), which shapes and conditions the attitude of students toward learning. Moreover, they have extended the TAM model by adding elements of teaching practices, perceived usefulness, intrinsic factors, and efficiency problems with the learning intentions in their research framework which involves the 460 final year student's responses, enrolled in a Computer Science and Software Engineering B.A. at an e-learning institution. Structural Equation Modelling (SEM) and Confirmatory Factor Analysis (CFA) have been employed in order to evaluate the relationship among the model's factors.

In conclusion, empirical evidence shows that effective teaching practices, the perception of usefulness & value, and coherent intrinsic motivations are the main instigators of the aspiration to study and learn programming.

At an institutional level, effective learning management systems must be provided that might encircle the face-to-face communication features in e-learning. Also, an effective student-teacher interaction must exist as students generally need immediate help during complex programming problems and the quick response availability can potentially be highly effective as students may plunge into difficulties and lose motivation.

Therefore, an interactive teaching environment and immediate assistance can help students broaden their knowledge, enhance their learning intentions, and facilitate the process of obtaining useful programming expertise in the e-learning context. (Rafique, Dou, Hussain, & Ahmed, 2020)

3. Central Research Questions and Research Methodology

The key objective of this work is to perform a comparative analysis on the effectiveness of learning delivery methodology by contrasting online learning to traditional face-to-face learning. The purpose of our survey is to identify if there exists (strong) correlations between the effectiveness of learning and the learning setting environment. In particular, this work investigates the following

1. What relationship, if any, exists between student satisfaction and teaching presence in online or face-to-face learning environments?

2. What role, if any, does the learning modality (online or face-to-face) have on the learning outcome / results?

3. What is the role of the teaching practices, learning intentions, expertise and efficacy on the learning outcome

4. What role, if any, play factors such as gender, level of study and type of higher education institution on the learning satisfaction and perceived effectiveness

To address these hypotheses, this paper uses quantitative research strategy and aims to measure the level of effectiveness of online learning in comparison to traditional learning for students enrolled in computer related fields.

The study was conducted among 205 students overall, 172 of which are bachelor students, and the remaining 33 are master students. 63% of all participants are enrolled in private higher education institutions, while the remaining 37% are enrolled in public institutions. 54.6% of participants are females.

The survey is organized in five thematic blocks, namely

- **Intrinsic factors** measuring the generic satisfaction with online learning methodologies and internal factors that might influence that
- **Perceived usefulness** aiming to compare the usefulness of online learning to

traditional learning and the main reasons behind these choices

- **Teaching practices** addressing the quality of online teaching materials alongside technologies that are used for digital learning
- **Learning intentions and programming expertise** estimate the level of (programming) expertise of participants.
- **Efficacy problems** measure the effectiveness and accessibility of online resources during programming challenges

These building blocks aim to explore not only the comparative differences between online and traditional learning but also to measure the most influencing factors behind these choices and the role that each of them plays.

4. Data Analysis

This study examines the links that exist between the student satisfaction and the teaching presence in online or face-to-face learning environments. It estimates the role that the learning modality has on the learning outcome and results for students enrolled in computer technology related areas. The conducted survey measures key components, such as: i) the intrinsic factors, ii) the perceived usefulness and direct comparison of the two learning methodologies, iii) the teaching practices, and iv) learning intentions, expertise and efficacy. A detailed analysis of results follows.

4.1. Intrinsic Factors

Our study shows that students are slightly in favor of considering their online learning experience as satisfactory, with 38,9% evaluating it either 4 or 5 on a 5-scale, 24.6% evaluating online learning satisfaction either 1 or 2, and the remaining 36.5% being neutral on the matter, as shown in figure 1. Similar results are encountered when asked if they prefer to enroll in an e-learning institution because of its flexible accessibility, or to take another higher degree course in their chosen field at an e-learning institution. They are generally able to follow up the online learning course materials alongside their regular schedule.
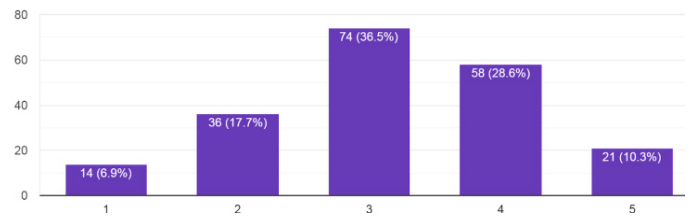
Figure 1: Level of satisfaction with online learning. The X-axis measures the level of satisfaction (from 1 to 5) while the Y-axis denotes the number of respondents
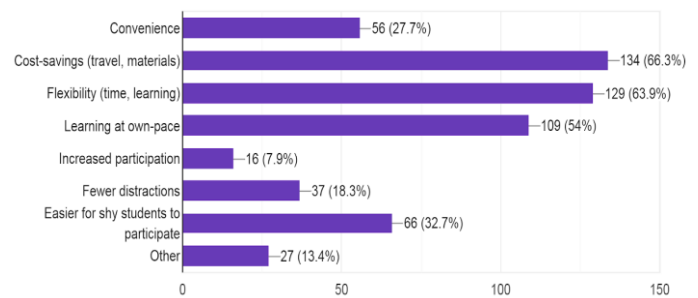
Figure 2: The major benefits of online learning. Note that participants are allowed to select as many alternatives as they consider appropriate. This causes the sum of all probabilities to be larger than 100%
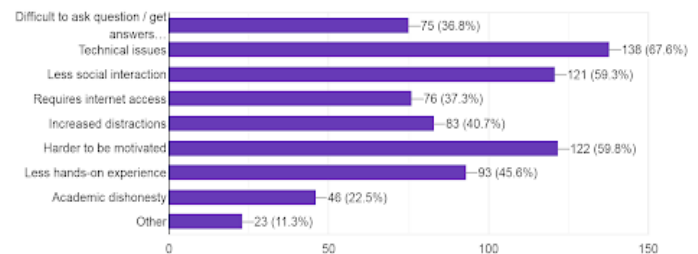
Figure 3: The greatest drawbacks of online learning. Note that participants are allowed to select as many alternatives as they consider appropriate. This causes the sum of all probabilities to be larger than 100%

Students consider online learning as a good opportunity to enhance their skills, complementary to their traditional learning environment. When asked regarding the greatest benefits of online learning, the majority of students highlighted cost-saving (travel, materials), flexibility (time, learning), learning at own pace, easier for shy students to participate as the most important benefits. Other factors such as convenience, fewer distractions and increased participation were considered moderately important.

In contrast to these advantages, participants in our survey considered technical issues, less social interactions, less motivation, less hands-on experience as the most important factors of the challenges encountered on online learning methodologies. Other factors such as difficulty to ask questions and get answers, the need for internet access, increased distractions and academic dishonesty are examples of other moderately important factors. Figure 2 and 3 provide a summary of these results.

4.2. Teaching practices

Our pool of participants generally agrees that the content quality of the course material presented online and the delivery of professors through online mediums is good and favorable. In particular, as shown in figure 4 a notable majority of 56.1% rate the content quality of course materials as satisfactory (they value it with either 4 or 5 on a 5-scale basis). Only 13.7% of students oppose. Similarly, as shown in figure 4, a majority of 54.2% of participants rate the delivery of online lectures as positive (they value it with either 4 or 5 on a 5-scale basis). 16.3% of participants disagree by rating the quality of online courses with either 1 or 2. The remaining students in both categories have a neutral opinion of the matter.
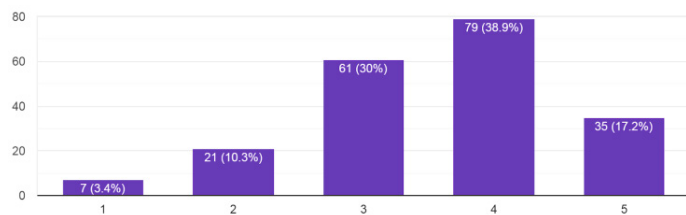

Figure 4: Students are asked "how they rate the quality of the course content presented online" from a scale from 1 to 5
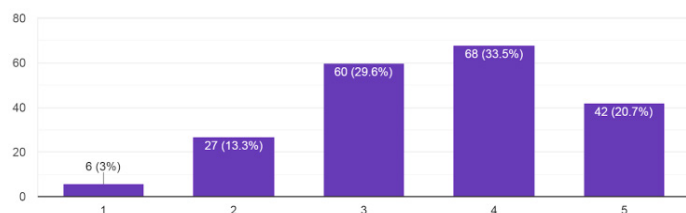

Figure 5: Students are asked "how they rate the lecture delivery of professors during the lectures presented online" from a scale from 1 to 5

However, as one can observe from the results in figure 6, students consider it as highly important to have step by step guidance for programming tasks (79% agree, 4% disagree, 17% are neutral) and to have one and one conversations with their lecturer (57% agree, 9% disagree, 34% are neutral). We consider both results to be correlated to one another. Though generally the content quality of materials presented online is satisfactory, students consider the presence of the instructor and interactiveness as important factors in their learning experience.
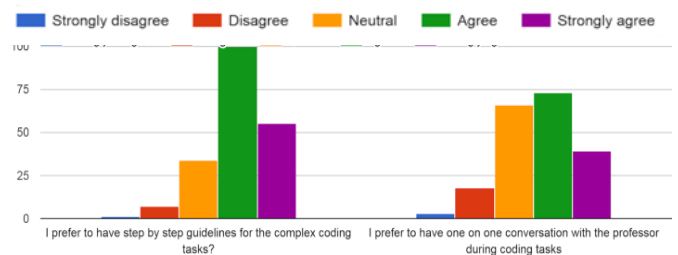

Figure 6: (on the left) I prefer to have step by step guidelines for the complex coding, (on the right) I prefer to have one on one conversation with the professor during coding tasks

4.3. Comparison of online to traditional learning

A key objective of this study is to directly compare the estimated efficiency of online learning methodologies to traditional approaches. For that reason, participating students were asked to value the effectiveness of each learning methodology, and their perception of the importance that the learning environment will have on their future jobs and careers.
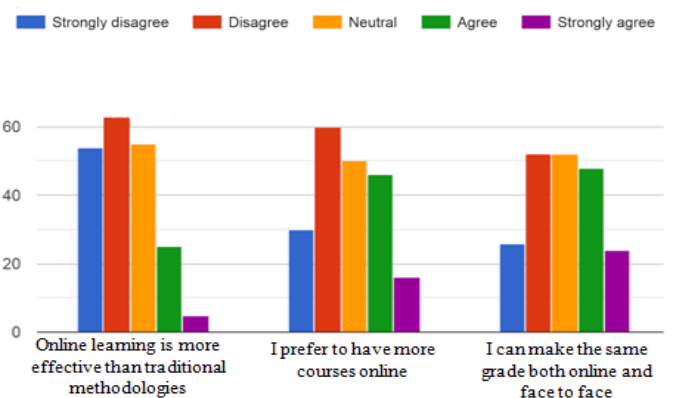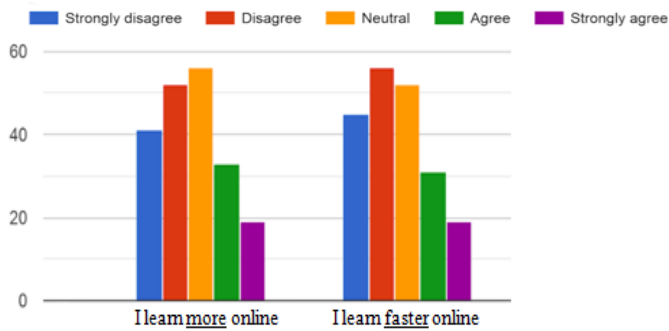
Figure 7: (both this and the previous graph) a comparison of the perceived usefulness of online learning in comparison to traditional learning

A notable majority of students (57.9% to 14.8%) think that online learning is less effective than traditional learning. Participants are generally undecided whether or not they can make the same grade in both learning environments (39% disagree, while 35% agree), and slightly not in favor of having more courses taught using the online methodology. In particular 45% of students do not prefer to have more courses taught online, while 31% are in favor of having more digital courses. A majority of students do not think that they can learn more (46% to 25.7%) or faster (50% to 24.8%) through online methodologies in comparison to traditional settings. Detailed results are shown in figure 7. In each category, the remaining students have a neutral opinion of the matter.

The impact of the learning methodology on future jobs and careers is correlated. Students seem dubious whether having online courses or the entire school curriculum delivered online will have a positive impact on their jobs (38.6% disagree, while 19.3% agree) and disagree that a total digital school curriculum will impact positively their future careers (57.4% disagree, while 14.3% agree). Again, the remaining students have a neutral opinion of the matter. Figure 8 shows detailed results.
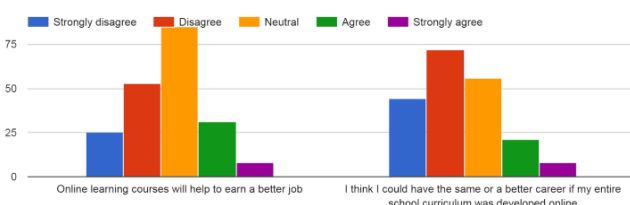

Figure 8: (on the left) Online learning courses

will help to earn a better job (on the right): I think I could have the same or a better career if my entire school curriculum was developed online

### 4.4. Learning intentions, expertise and efficacy

A notable majority of the participants of our study assess that they have a sound knowledge of programming, are motivated to expand their knowledge and work mainly on their own to complete assignments and projects. Figure 9 shows detailed results
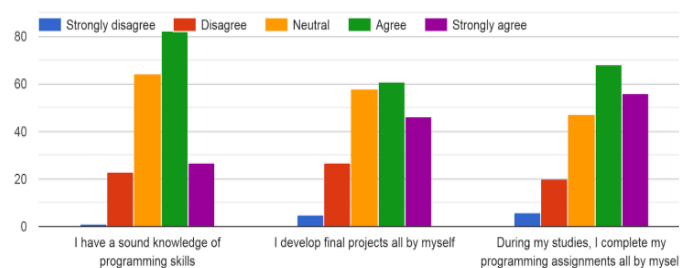
Figure 9: (left) I have a sound knowledge of programming skills; (center) I am motivated to learn programming; (right) I develop final projects and assignments by myself

As one can observe on figure 10, it appears that the main reasons for which students shift to online resources include requiring complementary help, online support, discussion forums, and to expand their knowledge. They seem to consider the online learning environment as a tool that complements their traditional choice of study.

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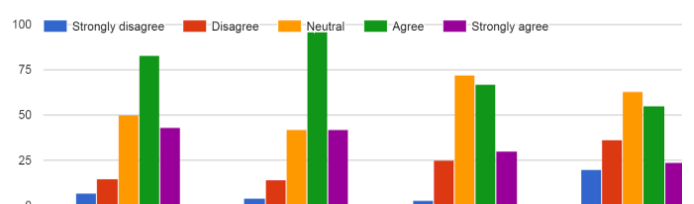
Figure 9: from left to right, students were asked the following

a. I can easily find support when I am stuck at a programming task
b. I find it easy to find the appropriate help online
c. I think software development tools (IDE) are easy to use
d. I find online platforms such as Zoom, Google Meets, Skype etc, efficient for learning programming.

Students are generally undecided regarding the effectiveness of online learning platforms such as Zoom, Google Meet, Skype, and similar software for learning programming.

4.5. Impact of Gender, Level of Study and Other Factors on the Survey Results

This section analyzes the impact that factors such as the gender of participants, their level of study (i.e., bachelor or master students) and the type of higher education institution (private or public) have on the survey results.

Our data analysis is focused only on a group of questions part of the survey. We are interested to investigate the role, if any, of the above mentioned factors on the perceived usefulness and the self-evaluation of the online learning methodology. In particular, consider the following statements:

- *Online learning is more effective than traditional methodologies*
- *I learn more through online methodologies than through traditional ones*
- *I learn faster through online methodologies than through traditional ones*

We have investigated the role that independent variables such as *gender, level of study* and *type of education institution* have on the result set. Table 1 provides a summary of our findings

Table 1 the role and impact of gender, level of study and type of education of the result set.. On each cell, the table shows the percentage of people who agree with the statement, are neutral, and disagree with it. For example, the numbers 15-27-58 in the first cell mean that 15% of participants agree, 27% have a neutral opinion and 58% disagree

	OL is more effective (in %)	I learn more through OL (in %)	I learn faster through OL (in %)
Overall	**15-27-58**	**26-28-46**	**26-26-48**
Female	10-23-62	19-31-50	17-26-57
Male	19-31-50	32-24-44	33-25-42
Private	15-25-60	25-24-51	23-25-52
Public	14-30-55	28-25-37	28-26-46
Bachelor	15-24-61	26-27-47	25-23-52
Master	16-41-43	32-32-36	22-38-40

As one can observe from the table, the most influencing factor is the gender of participants. A pattern is observed denoting that male students are more likely to consider online learning as more effective (19% males agree, while only 10% of females agree with the statement). Furthermore, male participants consider online learning a methodology that allows them to learn more (32% of males while only 19% of females) and faster (33% of males while only 17% of females). Female students, on the other hand, favor more traditional learning.

Another interesting observation is the fact that master students have the tendency to think that they can learn more through the online learning setting in comparison to bachelor students. Note that the pool of participants of master students is only 16.3% of the overall number of students.

The type of the higher level institution (private or public) or the level of study (bachelor or master) does not seem to have a notable impact on the results of our study.

4.6. Analysis of Results and Key Findings

A key objective of our study is to estimate the impact that the learning modality has on the learning outcomes for students enrolled in computer technology related areas

Results show that students enrolled in computer technology related fields view online learning as a favorable instrument for complementing their traditional learning environment and for providing instant access to high quality resources. Students assert that they have a sound knowledge of computing and keen to advance their programming skills. They are generally satisfied with the content quality and delivery of online courses and

highly appreciate cost-saving and flexibility advantages of online learning.

The consensus is uniformly distributed on issues such as the hypothesis that online learning will help students to earn a better job, or to have a better career if their curriculum is based entirely online. Students are generally undecided when asked if they would enroll in an e-learning course because of its flexible accessibility, or if they want to pursue another computer related degree at an online learning institution.

Our study shows that when asked for a direct comparison of the two learning settings and environments, students do not believe that online learning is more effective than traditional methodologies. The majority of students think that online learning does not allow them to learn more or faster than traditional learning. Technical issues, less social interaction, less motivation and less hands-on experience are the key factors behind such choices.

However, students highly appreciate cost-saving, flexibility (time, learning), ability to learn at their own pace, convenience and easy participation access for shy students as key elements of online learning. They tend to consider the digital learning methodology as a complementary tool that can enhance and improve their performance.

5. Summary and Recommendations

The rapid technological changes alongside with the opportunities to learn anytime, anywhere in a cost-effective approach have made online learning a popular and efficient model across the higher education spectrum. Despite the inherited advantages, the online learning methodology comes along with several challenges and difficulties ranging from technical issues to less social interaction, less motivation, and less hands-on experience among other factors.

This work presented the results of a study conducted to estimate the impact of the learning modality on bachelor and master students enrolled in computer technology related areas. The study focuses on measuring the role that intrinsic factors, teaching practices, learning intentions and programming expertise have on the perceived

usefulness and the efficacy of online learning.

Although the results of this study provide valuable insight into to benefits and difficulties of online learning in comparison to traditional learning, they can be extended even further to account for:

- a wider demographic distribution
- a broader range of areas of study in order to see the impact, if any, that the chosen degree of study has on the perception of the effectiveness of online learning
- a larger pool of participants from public universities
- a refinement of factors that affect the choices between favoring one learning environment to another and the links between them

The results of this work might be proven beneficial to students, instructors, administrators and policy makers on their process of adapting to continuous technological changes and improvement of the learning process. The following recommendations can be drawn from the results of our study

i)   Online learning is considered as a useful complementary methodology for students enrolled in computer technology related fields.

ii)   Higher education institutions must advance their technological environments to create effective, cost-saving and innovative approaches for distance education

iii) Online learning challenges such as technical issues, less social interaction, less motivation, less hands-on experience need to be addressed in a principled manner as implications might arise and affect the education system in its fullness, rather than online learning in particular.

iv)   Unexpected events alongside with the need to minimize the effect of geographical boundaries, time and distance dimensions require the higher education institutions to be prepared for integrating the online learning methodology in an effective manner to a preparedness for shifting towards it if and when necessary

Finally, the learning process is a multi-way

partnership between students, course providers, education institutes, and regulatory systems among others. The notable advancements in the technology related fields demand an all-considering effective integration of learning methodologies in order to successfully tackle the numerous challenges of the education system.

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