The Effectiveness of using the Simulation Technology on Students' Performance in the Course Personal Identification Techniques at the University of the Cordilleras

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Abstract:- Due to the sudden shift of learning modality to online distance learning, an automated fingerprint simulation technology was developed to enhance the skills of students in identifying and matching fingerprints. However, it is not fully deployed in Higher Education Institutions offering criminology programs. The objective of this study is to find out the effectiveness of the simulation technology on the performance of students enrolled in the course Personal Identification Techniques at the University of the Cordilleras. An experimental research was utilized through a pre-test-treatment-posttest design. The respondents were divided into two groups, the experimental and the control group. A pre-test and posttest regarding the identification and matching fingerprints were administered to both groups, while the experimental group received an intervention by using the simulation technology. The data gathered was tabulated and statistically treated using a two-sample independent t-test and a paired t-test. Findings revealed that there is no statistically significant difference in the performance of both groups in the pre-test which implies that the respondents from both groups have the same knowledge about the content of the test. Meanwhile, there is a statistically significant difference between the experimental group and control group in the posttest which denotes that the experimental group performed better than those without intervention. Furthermore, there is no difference in the mean scores in the pretest and posttest of the control group. Hence, students from this group showed no improvement in their performance. While the mean scores of the experimental group are statistically significant which entails that the students who used the simulation reported better test results. Therefore, the simulation technology proves to have a powerful effect that improves the performance of the students in identifying and matching fingerprints.

Keywords:- *Technology, Simulation technology, Personal identification techniques, Students' performance, Fingerprint.*

I. INTRODUCTION

The Covid-19 pandemic has disrupted the operations of educational sectors affecting all students from various levels, especially the most vulnerable learners (UNESCO, 2022). It has induced the transition of many educational institutions to online learning (Costa, 2021) and created an opportunity to reshapehigher education through the development, diffusion, and implementation of digital technologies for the improvement of the sustainable development of teaching (Sá &Serpa, 2020).In response, several educators had to re-design courses (Moorhouse, 2020) and deliver them on a virtual platform (World Economic Forum, 2022a). Thus, recognizing the vital role of technology in sustaining learning in these challenging times (Al Kodri, 2020).

Meanwhile, Higher Education Institutions (HEIs) in the Philippines had to shift from traditional learning to flexiblelearning modalities as mandated by the Commission on Higher Education (CHED) in accordance with the CHED Memorandum Order No. 4 on the implementation of Flexible Learning Modality (CMO 4, 2020).In the country, the Criminology program is considered one of the most populated programs having 604 HEIs offering the program as recorded by the Professional Regulation Commission (PRC)based on the December 2021 Criminology Licensure Examination results. The program offersPersonal Identification Techniques in the subject area of Forensic Science which aims to help criminology graduates acquire the competence and skills needed by the industry in Personal Identification through dactyloscopy and other techniques (CMO 5, 2018).

However, with the current educational setting, it remains unclear how effective is the delivery of the course in ensuring that students acquire the necessary skills in the course. In this regard, a virtual automated fingerprint identification system (AFIS) simulation technology was developed which allows students to refine their skills in identifying minutiae and matching questioned fingerprints to a set of standard fingerprints. Yet, despite its existence, it is not fully deployed and utilized by HEIs offering the program.This studyaims to better equip criminology students with tools to refine their skills in identifying the minutiae and matching a questioned fingerprint to a set of standard fingerprints, help faculty members design effective course activities aligned with the learning outcomes,help criminology administrators to re-manage and re-design courses to meet the needs of the

students, and support criminology schools in their endeavor to produce competent graduates needed by the industry.

II. LITERATURE REVIEW

Educational sectors strive for the enhancement of instructional techniques and methodologies in boosting students' learning experience through the integration and utilization of educational technologies in online distance learning (ODL) due to the pandemic (Butnaru et al., 2021). ODL enables universities and colleges to make learning accessible to students who are unable to physically attend classes due to Covid-19 restrictions. It is a form of education where there is a physical separation of teachers and students during instruction and involves the use of various technologies to facilitate student-teacher and student-student communication (Britannica, 2022).

In this regard, educational technology serves as an indispensable component. Educational Technology (EduTech) is the effective use of technological tools in learning which includes various types of media. It is the integration of computer-based programs, online learning, mobile technologies, and other forms of media in instruction to augment the traditional method of teaching (Mulyadi et al., 2020).

In response to the unprecedented event due to the pandemic, several educators had to re-design courses (Moorhouse, 2020) and deliver them on a virtual platform (World Economic Forum, 2022a). Thus, recognizing the vital role of technology in sustaining learning during these challenging times (Al Kodri, 2020). This is evident when the study by Ali (2020) reveals the necessity of online learning in times of lockdowns caused by the pandemic. As shown in the article of World Economic Forum (2022b), there has been a proliferation of the use of technology in education in the United States (U.S) before and during the pandemic.

With its drastic increase, the use of educational technologies hasincreasedthe retention of information among students (World Economic Forum, 2022). However, numerous studies have identified drawbacks to online distance learning. For instance, Dubey & Pandey (2020) found that ineffective learning activities are one of the challenges experienced by higher education during the pandemic. It was further substantiated in the study conducted by Adnan (2020) which reveals that online learningcannot produce desired results in underdeveloped countries like Pakistan due to these challenges.

Whereas Price & Kirkwood (2013) believes that its educational effectiveness in online distance learning is still open to question. In addition, Anderson &VanPortfliet (2013) likewise argued that academic achievement and retention are worse for students following distance learning programs than for those being taught in traditional classroom settings. Yet, Khan (2021) said that the key to addressing these challenges lies in the recognition of innovative and helpful approaches like maximizing the capacity of educational technologies (Khan, 2021). Hence, educational technology can also be a means to an end to improve learning outcomes.

One of the emerging pedagogical approaches to providing students with the opportunity to practice learned skills is the simulation-based education(Greenwood, 2021). It enables students to experience active problem-solving in a safe learning environment and teachers can assess if students have developed a level of competency when placed in simulated situations(Pangea, 2021). For instance, in various European Universities simulation-based education has been introduced online and on-campus (Campos et al., 2020). It was also mentioned in the study of Damewood (2016) thatsimulation is one of the current trends in Higher Education Technology. It is often deployed in the field of medicine just like in the study of Medley and Horne (2005) which discusses how simulation technology is used to enhance undergraduate nursing education. Scalese et al. (2007) also identified thatsimulators can be used for reliable assessments of competence.

Meanwhile, in the field of criminology, the study of Tudy & Tudy (2014) showed that criminology students preferred visual learning. The student preference for visuals gives the impression that they can better learn by seeing materials or things such as writings on the board, videos, written directions, charts, diagrams, and even faces of people. In addition, most students in State Colleges and universities in Caraga Region are likely to use technology in the classroom for positive consequences supporting the view that the use of technology helps in enhancing learning-related activities in the classroom (Gorra, 2016).While in the study conducted by Steven Stack (2013), students showed higher academic performance in online instruction as compared to offline instruction or the traditional method of teaching. Hence, edutech may be a key factor in improving criminology students' learning.

The adoption of edutech in the field of criminology in the Philippines has grown slower as compared to other disciplines. There are limited research studies on the development and integration of edutech in criminal justice education. Meanwhile, one of the major challenges of HEIs offering criminology programs is the effective delivery of technical courses in online distance learning. Benter (2020) identified a lack of laboratory facilities that can hamper the academic performance of criminology students. Based on the criminology curriculum, among the technical courses under the subject area of Forensic Science is the Personal Identification Techniques. The course aims to help criminology graduates acquire the competence and skills needed by the industry in Personal Identification through dactyloscopy and other techniques.With the current educational setting, it remains unclear how effective is the delivery of the said technical course, given that most instructors and students had little experience with online education coupled with a lack of laboratory and technological resources available online.

In this regard, a virtual automated fingerprint identification system (AFIS) simulation technology was developed in hopes of addressing the problems. This technology allows students to refine their skills in identifying minutiae and matching questioned fingerprints to a set of standard fingerprints where each questioned and standard fingerprints have twelve (12) predetermined plots that they

must label according to their characteristics. Furthermore, this technology can be accessed through a web application. However, despite its existence, this technology is not yet fully deployed and utilized by HEIs offering the program.

III. STATEMENT OF THE PROBLEM AND HYPOTHESIS

This study aims to assess the effectiveness of the Virtual Automated Fingerprint Identification System (AFIS) Simulation Technology in enhancing the skills of students in identifying and matching fingerprints as well as in improving the course Personal Identification Techniques. Such evaluation will serve as the basis of the enhancement of the technology to fit with the needs in the delivery of the course.

In light of this, the study seeks to answer this research question:

- Is there a significant difference in the scores of the experimental group and control group?

Ho: There is no significant difference in utilizing the Virtual Automated Identification (AFIS) Simulation technology in improving students' performance in the course Personal Identification.

IV. METHODOLOGY

A. Research Design
Quantitative research, specifically experimental design through a two-group pre-test-treatment-posttest design was used in the study. According to Rennison& Hart (2019 p.224), experimental research is an approach that is useful for identifying causal relationships between variables. It is a scientific approach to research, where one or more independent variables are manipulated and applied to one or more dependent variables to measure their effect on the latter. The effect of the independent variables on the dependent variables is usually observed or recorded over some time, to aid researchers in drawing a reasonable conclusion regarding the relationship between these two (2) variable types (Form Plus Blog, 2020).

In the study, a two-group pre-test-treatment-posttest design was utilized for it is considered a true experimental design. It involves randomly assigned experimental and control groups, and manipulation of the independent variable by the researcher. Furthermore, pre-tests and posttest are used to compare groups after the treatment enabling a more precise assessment of the treatment (Rennison & Hart, 2019 p.254).

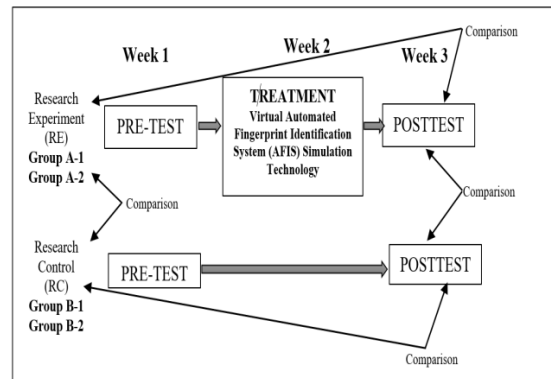Below is an illustration of the Two-group Pre-test-Treatment-Posttest Design:

Fig. 2: Two-group Pre-test-Treatment-Posttest Design

In the study, a pre-testwas initially administered during the 1st week then posttest measures were takenin the 3rd week after the treatment period among the experimental group to assess the scores of students after using the simulation technology.Afterward, a comparison of the pre-test and posttest scores between the experimental and control group was made. Moreover, the pre-test and posttest scores of each group (control and experimental) were compared to determine whether there exists a significant difference in the scores of students with the utilization of simulation technology.

B. Population and Locale of the Study
The study was conducted at the University of the Cordilleras (UC), College of Criminal Justice Education (CCJE), a consistent top-performing school and a CHED Center for Excellence for Criminology. To qualify as respondents in the study they should be currently enrolled in the course Personal Identification Techniques and have participated in the pre-test and posttest. The respondents were selected and grouped randomly through the Canvas learning management system.

Furthermore, a probability sampling method, specifically, simple random sampling was used. Ina simple random sampling method, each element in the population has a known and equal probability of being drawn or selected into the sample (Rennison&hart, 2019 p.149). Students from two class sections were grouped using the Canvas learning management system of the university into two (2): the experimental and control groups. However, those students who unofficially dropped the course and were not able to participate in both pre-test and posttest were not included.

In addition, the students were categorized based on their sections. Each section will be divided into two (2) groups, namely *Group A* and *Group B*. *Group A* serves as the experimental group, while *Group B* represents the control group. Since there are two (2) sections, symbols like *-1*for Section 1 and *-2* for *section 2* were used to signify which section they belong to.Thus, there are two (2) experimental groups, namely *Group A-1* and *Group A-2*, and two control groups, *Group B-1* and *Group B-2*. Hence, there are thirty-five (35) students from the experimental group and twenty-nine (29) students from the control group*(See Table 1).*

SECTION	GROUP A (Experimental group)	GROUP B (Control group)	TOTAL
1	15	11	26
2	20	18	38
TOTAL			64

Table 1: Respondents' Profile

C.Research Instrument

The researcher utilized Pre-test and Posttest tests to obtain the necessary data for the study. A pre-test and posttest were administered to the control and experimental group in a form of laboratory activity with the objective of assessing the students'skills and knowledge in identifying and matching fingerprints. The instrument was checked by the Personal Identification instructor for its accuracy. *(See Appendix A and B)*

D. Data Gathering Procedure

The researcherssought permission to conduct the study and prepared a letter addressed to Dr. Cherry Ann A. Cabarrubias, Dean of the College of Criminal Justice Education as endorsed by Dr. Robino D. Cawi, Graduate Program Coordinator. After its approval, the researchers conducted an orientation among the respondents and informed them of the purpose and nature of their participation in the study. The researchers ensure the respondents that their responseswould be treated with the utmost confidentiality and their participation is voluntary. With the permission of the instructor handling the course, the researchers administered the pre-test and posttest through the Canvas learning management system. Both the experimental and control group were given one (1) week to submit the pre-test and posttest.

During the first week,the pre-test was administered to both groups. Afterward, the researchers scheduled a meeting among students from the experimental group for them to utilize and explore the simulation technology in the second week. The technology developers instructed them on the use of the simulation technology and allowed the experimental group to explore its features for one (1) week. Finally, in the third week, the posttest was administered, and the respondents were given one (1) week to accomplish the activity. Their responses were documented and checked using the key answers. Consequently, the data gathered were subjected to statistical analysis and interpretation with the help of a statistician.

E. Statistical Treatment

T-test was used to find the significant difference in the scores of the students before and after using the simulation technology. It is a type of inferential statistics to determine whether there is a significant difference between the means of two (2) groups (Siegle, 2015).

Following the design of the study, a multi-stage analysis of data was performed. To measure the difference in the pre-test and posttest scores between the experimental and control group, Two-sample Independent T-Test was employed. The formula is:

$$t = \frac{\overline{x}_1 - \overline{x}_2}{\sqrt{(s^2(\frac{1}{n_1} + \frac{1}{n_2}))}}$$

Where *t* is the *t-value*, x_1 *and* x_2 are the means of the two (2) groups being compared, s^2 is the pooled standard error of the two (2) groups, and n_1 and n_2 are the numbers of observations in each of the groups. Further, to determine the difference between the pre-test and posttest score of each group, a Paired T-test was used. The formula is:

t = d/s/√n

Where *d* is the mean sample difference, *s* is the standard deviation of the sample differences and *n* is the sample size.

F. Ethical Consideration

Informed consent was obtained by detailing the purpose of the study and the strategies to ensure the respondents' anonymity. After they voluntarily sign the consent forms, confidentiality was explained to them before the conduct of the study. The informed consent includes that the student respondents could withdraw from the study at any point if they no longer feel comfortable.

V. RESULTSAND DISCUSSIONS

This section presents the data, analyses, and interpretation of the data gathered in the study.

A. The difference in the test results of students in using the simulation technology.

To determine the difference in the test result, pretest and posttest were administered among the respondents from the control and experimental group.*Table 2* illustrates the data on the pretest scores of the experimental and control group before any treatment has been administered. The control group obtained a *mean* of *16.68*, while the experimental group obtained a *20.14 mean*. It can be noted that the mean scores have a trivial discrepancy. The discrepancy is not statistically significant as indicated by a computed *p-value of 0.06*.

Pretest	Mean	t	p
Control Group	16.68	1.88	0.061^{ns}
Experimental Group	20.14		

Table 2: The Pretest scores between the Experimental Group and Control Group

This implies that the respondents from both groups have the same knowledge about the content of the test. Hence, there is no significant difference in the pretest scores of the control and experimental group. In this regard, the pretest result does not demonstrate significant gains in the knowledge and skills of the students. A similar study conducted by Delucchi (2014) revealed that pretest results can only establish students' prior knowledge, usually, at the beginning of the trimester. In a related study, Berry (2008) also considers the pretest as a non-graded assessment tool in determining the pre-existing knowledge of the students and the administration of the pretest only serves as a motivational tool and a 'road map' for the students resulting in improved course performance. With this, the administration of the pretest aims to assess their prior knowledge of the topic. Besides, since the pretest was administered after the discussion on identifying and matching fingerprint patterns, it served as an assessment tool for their prior knowledge of the topic. Hence, the pretest results of the control and experimental group showed no significant difference.

Furthermore, *Table 3* shows the posttest result of the respondents from the control and experimental groups. This is to show whether there exists a significant difference in the test results of the respondents in the posttest. Based on the findings, the control group obtained a *mean of 17.24*, while the experimental group obtained a *37.85 mean*. It can be noted from the table that the mean score of the students from the experimental group is statistically higher than the control group as evident by the computed *p-valueof 0.032*.

Posttest	Mean	t	p
Control Group	17.24	2.89	0.032^{*}
Experimental Group	37.85		

Table 3: The Posttest scores between the Experimental Group and Control Group

This means that the group of students who utilized the simulation performed better than those without intervention (Automated Virtual Fingerprint System Simulation technology). In this regard, the null hypothesis is rejected. Therefore, there is a significant difference in the posttest scores of the experimental group and control group. As mentioned by Delucchi (2014), a posttest measures learning at the end of the course. Therefore, the posttest assessed the academic performance and skills of students in identifying and matching fingerprints. Based on the findings of the study, students belonging to the experimental group scored higher than those who belong to the control group. Whereas the experimental group received treatment using the simulation technology targeting the learning objective of the course in identifying and matching fingerprint patterns. According to Howard Gardner's Theory of Multiple Intelligence, students have different strengths and intelligence. Therefore, teaching them one method is not enough to measure their performance.

Considering students' multiple intelligence can be used for curriculum development, planning instruction, selection of course activities, and related assessment strategies. Students' multiple learning preferences can be addressed when instruction includes a range of meaningful and appropriate methods, activities, and assessments (Gardner, 2010). In this regard, the introduction of the simulation technology among the experimental group may be a motivational factor that improved their performance as shown in their posttest results compared to the control group. In a study conducted by Shivaraju et al. (2017), there was a significant improvement in the recipient of knowledge after a post-lecture assessment. The distinction of scores between the control and experimental group may be due to the treatment received by the experimental group.

Moreover, this finding is further supported by similar studies which affirmed that using educational technology can significantly increase the academic achievement of the students (Ababa et al., 2021; Bağcı&Pekşen, 2018; Mergany et al., 2021). In a study conducted by Mergany et al. (2021) on the effect of mobile learning on the academic achievement and attitude of Sudanese dental students: a preliminary study, there exist a statistical difference between the pre-test and post-test scores of the intervention group while the differences were not significant among the control group. In addition, based on the study of Bağcı & Pekşen (2018), mobile learning which is a form of educational technology may promote students' academic achievement. Ababa et al. (2021), also revealed that educational applications significantly improved the academic performance of the students. On the other hand, the study of Lopuch (2013) on the effects of student achievement and engagement revealed that there is no observable impact of the educational apps on either achievement or engagement. It was further emphasized that when highly curated apps are aligned to student needs, students can make substantial progress. Nonetheless, several findings showed that using educational technology affects the academic achievement of students. However, careful consideration of the alignment of such educational technology on the student needs as well as on the learning objectives.

Further, *Table 4* shows the pretest and posttest scores of the control group. The control group obtained a *mean of 16.68* in the pre-test while *17.24* in the posttest. With this, the control group showed no difference when their mean scores in

pretest and post-test were compared. This is supported by the *p-value of 0.058.*

Control Group	Mean	t	p
Pretest	16.68	1.98	0.058ns
Posttest	17.24		

Table 4: The Pretest and Posttest scores of the Control Group

This implies that the students from this group showed no improvement in their performance. Hence, there is no significant difference in the test results of the control group. Based on the finding, it can be posited that there is no improvement in the students' academic performance as shown in their test results. According to Malcom Knowles, as cited by Kurt (2020), adult learners require a unique approach to learning. Since no intervention has been introduced to this group, their skills in identifying and identifying fingerprints remain the same. Therefore, the finding suggests that the result is due to the manipulation of the independent variable rather than extraneous variables which is necessary for experimental research.

Meanwhile, *Table 5* presents the pretest and posttest scores of the experimental group. The experimental group obtained a *mean of 20.14* in the pre-test while *37.85* in their posttest result. In this regard, the mean scores are statistically significant as indicated by a *p-value of 0.44*.

Experimental Group	Mean	t	p
Pre-test	20.14	2.78	0.044*
Post test	37.85		

Table 5: The Pretest and Posttest scores of the Experimental Group

This entails that the students who used the simulation reported better test results. Thus, there is a significant difference in the pretest and posttest scores of the experimental group. As shown in the studies of Ababa et al., (2021), Bağcı&Pekşen (2018), and Mergany et al. (2021), the intervention group (experimental group) showed a significant increase in the test results. The improvement of their test result is a manifestation that the treatment (simulation technology) influences their performance. According to Malcom Knowles, as cited by Kurt (2020), in his Andragogy theory, asserts that adult learners require a unique approach to learning. The treatment may have provided them with a distinct learning experience that facilitates the learning and retention of information.

Moreover, in relation to the Kirkpatrick Model, four levels of learning evaluation were identified such as reaction, learning, behavior, and result (Kurt, 2018). Result is classified as level four (4) in learning evaluation which determines if the material had a positive impact on the business/organization (Kurt, 2018). In relation to the study, the learning material (simulation technology) created a positive impact on the test results of the students from the experimental group. This also increases the retention of information among students as mentioned in the article of World Economic Forum (2022).

Therefore, the overall findings of the study suggest that both groups (control and experimental) showed no significant difference in their pretest results in identifying and matching fingerprints. However, after the utilization of the simulation technology of the experimental group in the study, there was a significant increase in their posttest results, while no significant difference was observed in the control group. Hence, the use of the simulation technology enables better results in the achievement of the learning objective of the course Personal Identification, specifically identifying and matching fingerprints.

VI. CONCLUSION

Based on the findings of the study, it can be concluded that the simulation technology improves the performance of the students in identifying and matching fingerprints.It is a good instrument to test and harness students' knowledge and skill for it allows them to accomplish the activity hands-on. Hence, it is an effective tool that facilitates learning among criminology students enrolled in the course Personal Identification Techniques.

VII. RECOMMENDATION

In light of the findings and conclusion of the study, it can be suggested that the use of simulation technology may be integrated into the course syllabus and be used by criminology instructors handling the course as a tool to supplement and deliver the course in a flexible learning modalitythrough the support of the Criminology Deans and Program Chairs. Moreover, Higher EducationInstitutions offering Criminology Programs in the Philippines may explore this technology to supplement, address the lack of educational resources in online distance learning, and facilitate learning and acquisition of skills needed by the industry.

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