Establishing Physics' Lecturers Pedagogical Technology knowledge

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Abstract- The objectives of this article are to examine aspects of teaching physics technology knowledge, and determine whether the academic performance of students who study physics 101, 102, and physics labs differed significantly after integrating information techniques. Essentially, this research article employed empirical data gathered from the answers of 425 students of Applied Science Private University who take physics 101, 102, and physics laboratories. A questionnaire makes up the data collecting tool. Our research's conclusions provide physics lecturers, decision-makers, and leaders with understanding and direction in determining the requirements of the pupils. According to the results of the present study, pedagogical development and technology development occurred by using lecturers with high levels whose engagement is advantageous to the community. The results also showed that senior instructors and fewer professors had smaller beginning samples when it came to "beliefs regarding the relevance of technology.

Index Terms- Physics, Pedagogy, Technology, knowledge, Community.

I. Introduction

prior studies on technology integration in physics classrooms and laboratories focused on the mental learning outcomes and processes of the students [1]. However, it is now commonly acknowledged that the sluggish adoption of technology by students has prevented many improvements in classroom procedures. Therefore, it is essential to comprehend how to enhance students' understanding and practice about integrating technology in their studying as part of pedagogical development programs.

Additionally, it seems that academics have been focusing on the necessity to examine physics lecturers' understanding of utilizing digital technology in the classroom during the past 10 years. The complexity of this knowledge—which itself is the result of the need to create a didactic situation that involves the organization of numerous educational relationships and necessitates a shift in lecturers' perspectives—drives the need for further research into the degree to which physics lecturers possess the knowledge necessary for integrating technology in classroom practices. Lecturers' understanding must advance in order to effectuate such a shift in perspective. The emphasis is on assessing physics teaching strategies and providing data that educators should use when creating a curriculum to fit the needs of their students. For creating a pedagogical development program aimed at advancing physics lecturers' knowledge of technology integration, the Community of Inquiry framework has been suggested [11]. Through the use of two main themes—lecturers' knowledge and pedagogical development program design—the current study aims to explore lecturers' pedagogical technology knowledge and its growth within the framework of a community of inquiry pedagogical development program [12].

II. 2. Preliminaries

For creating a pedagogical development program aimed at advancing physics lecturers' knowledge of technology integration, the Community of Inquiry framework has been suggested through the use of two main themes—lecturers' and students' knowledge and pedagogical development program design—the current study aims to explore lecturers' pedagogical technology knowledge and its growth within the framework of a community of inquiry pedagogical development program.

III. 3. Literature Review

A. Lecturers' Knowledge

Education research has been primarily focused on lecturers' knowledge during the last three decades since it has long been understood that lecturers' knowledge is essential for implementing changes in classroom practice and frameworks for lecturers' knowledge, including frameworks related to the emotional domain of lecturers' knowledge.

B. Pedagogical Development Framework

Researchers have tried to find frameworks for the professional development of physics lecturers in the lack of a "grand" theory for lecturers' pedagogical development. For instance, Schoenfeld [2] proposed a framework that focused largely on the individual lecturer and covered the knowledge, objectives, and beliefs of lecturers. Action, reflection, autonomy, and networking make up Krainer's [3] four-dimensional framework for lecturers' professional activity, which is founded on both personal and societal factors as illustrated in Figure 1.

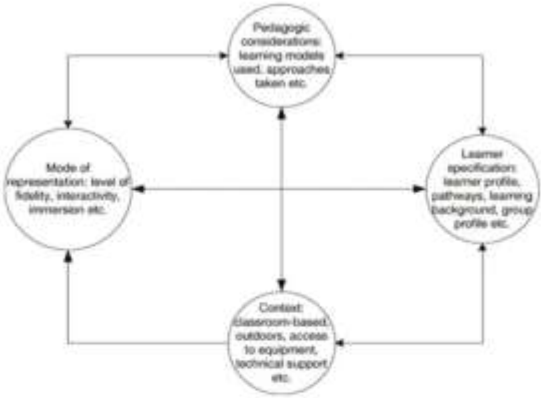

Figure 1: Four-dimensional framework

Linares and Krainer [4] also highlighted the social and individual components, highlighting the fact that examining lecturers' professional growth necessitates addressing the issue at the organizational, social, and individual levels. Another framework that takes social and organizational factors into account is that of Clark-Wilson et al. [5], who identified five factors related to mathematics lecturers' professional development with regard to integrating technology: (a) the institutional context; (b) the design of mathematics lecturers' pedagogical development programs; (c) the pedagogical development activities of lecturers with technologies, whether they are part of formal pedagogical development programs or not; (d) lecturers' use of technology in their classrooms; and (e) meta-level reflection. The current pedagogical development program makes use of the Community of Inquiry concept in connection with Wenger's community of practice concept. The concept of a community of inquiry [10], as illustrated in Figure 2, refers to a group of people who collaborate on a shared endeavor to advance their knowledge by critically analyzing their actions with an open mind. Community of Inquiry is a place where the earlier customs are still followed. In our instance, the Community of Inquiry comprises of math instructors that prepare and deliver math classes that include technology as their profession. They do research by doing this according to Goodchild.

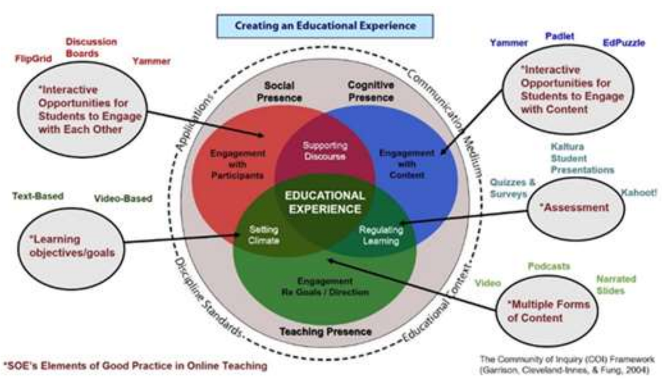

Figure 2: Understanding the Community of Inquiry Framework

C. Research Issues

1. Are there statistically significant links between pedagogical technology knowledge and its many components, including pedagogical knowledge, understanding of physics content, the history of how the technology was used, lecturers' confidence in utilizing it, and lecturers' opinions on its value?
2. Do seniority, amount of technological integration, and job status all affect the pedagogical technology development level in statistically meaningful ways?
3. Do lecturers who take part in a pedagogical development program built on a Community of Inquiry framework have significantly different pedagogical technology knowledge scores?
4. Do participants in the Community of Inquiry pedagogical development program's background variables—such as seniority, amount of prior technology integration, and employment status—affect changes in the pedagogical technology knowledge components?

D. Participants

The "Using Technology in Learning Physics" study, which is being done by undergraduate students at Applied Science Private University, contains 425 students from four faculties: pharmacy, arts and sciences, computer technology, and engineering. It is intended to determine the level of technology used in laboratories and physics classes. The following several query writers have are based on correlations between technology use and academic performance:
H1: A student's thinking skills will be improved if lecturers use pedagogical technology knowledge during classes.
H0: The more pedagogical technologies used by lecturers will have a detrimental impact on student thinking skills.
Reliability and validity are assured via an inductive study of the survey's data.

E. Research Tools

Our students were required to complete a questionnaire while taking Physics 101, 102, and physics laboratories. We started the one-way analysis of variance (ANOVA) table and used an independent sample t-test to compare the findings based on demographic variables. Between the questionnaire axes, we determined the Pearson correlation coefficient. Now, data analysis was done using SPSS version 22, which yielded the study's Cronbach's Alpha, which is 0.875. The threshold for statistical significance were set at p.05 (two-sided). P .01 is the threshold for statistical significance when analyzing the correlation coefficient (two-sided). We used a pedagogical technology knowledge questionnaire as the data collection tool.

A total of 425 students were enrolled in the study, with 44% males and 56% females making up the sample. About 54.30% of them are affiliated with the faculty of Pharmacy, which is followed by the faculties of Computer technology (12%), Engineering and technology (29.9%), and Arts and science (3.8%). The fraction of the entire sample that has cumulative averages higher than or equal to 84% is 55.70%. Although it's a fiercely debated topic, researchers found it fascinating that despite using two different activity zones, men and women score equally on cognitive ability tests.

Table 1 reveals the research sample's demographic characteristics

Variable	Category	*n*	%
Gender	Male	178	41.4
	Female	247	58.6
Age	18-20	255	60.0
	21-23	120	28.6
	24-26	28	6.2
	Greater than 26	22	5.3
Academic year	1st	194	46.0
	2nd	83	18.8
	3rd	63	14.7
	4th	48	11.9
	5th	37	8.6
Cumulative average	Acceptance	15	29
	Good	82	19.1
	Very good	173	40.8
	Excellent	155	36.6

The mean, standard deviation, and attitude for each of the components of the pedagogical technology knowledge are now shown in Table 2

Table 2: mean, standard deviation, and attitude

No	Item	Mean	SD	Attitude
1	I like to solving problems using technology	4.0	0.9	Agree
2	I like solving problems that need calculating programs	3.70	1.03	Agree
3	I like to solve problems using technical sources and programs	3.62	1.0	Agree
4	I do my best in solving physics problems that need technical programs	4.16	0.83	Agree
5	I make great effort when I cannot solve physics problems without using technology	4.12	0.83	Agree
6	I can solve physics problems using technology	4.04	0.83	Agree
7	I spend a long time when I solve problems without using technology	3.70	1.01	Agree
Confidence Cronbach's Alpha = 0.825		3.75	0.53	Agree

With a "Agree" attitude, item "4" has the greatest mean. The second place goes to item "5," which has a "Neutral" attitude with a mean of 4.12 and a standard deviation of 0.83. High Cronbach's alpha indicates that the metric we utilize in our study work is legitimate, and its value reflects this. There are several reasons why some students find it so difficult to understand physics ideas, and having trouble with the issue might make you feel bad. Courses must be made interesting and practical with lots of real-world applications by the students.

Table 3 reveals Pearson's correlation coefficients between the two criteria (variables)

	Improve PTK	Impact PTK
PTK improve thinking skills	1	0.33**
PTK impact thinking skills	0.33**	1

Table 4 shows that the criteria (Impact PTK and Improve PTK) have a slight positive association (r=0.33, p=0.000–0.01).

Gender		N	Mean	St Deviation	St Err Mean
Improve PTK	Male	178	3.75	0.54	0.05
	Female	247	3.74	0.54	0.04
Impact PTK	Male	178	3.03	0.75	0.07
	Female	247	2.95	0.79	0.06

Independent samples T tests are displayed in Table 5.

Variable	t	Degrees of Freedom	Sig. (2-tailed)	Mean Difference	St Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Improve PTK	0.553	289	0.57	0.034	0.065	-0.089	0.16
Impact PTK	1.0990	289	0.278	0.099	0.091	-0.08	0.279

There are no significant differences based on gender are between the two criteria.

Table 5 includes the mean and standard deviation for faculty constructs, with the variation highlighted to show the influence of the students' majors.

Variable	**Category**	**Mean**	**St. D**	**N**
Improve PTK	Engineering	3.8	0.563	127
	Pharmacy	3.7	0.538	212
	IT	3.79	0.475	51
	Chemistry	3.86	0.499	35
Impact PTK	Engineering	2.97	0.647	127
	Pharmacy	2.91	0.766	212
	IT	3.23	0.949	51
	Chemistry	3.50	0.879	35

Table 6: ANOVA

Variable	Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
Improve PTK	0.635	3	0.211	0.732	0.532
Impact PTK	6.226	3	2.076	3.575	0.015

Table 6 shows that the faculty has a substantial impact on pedagogical technology knowledge (PTK), with a p-value of 0.014, 0.05, and F=3.574. According to the LSD test, post-hoc comparisons suggest that the means of students studying engineering and pharmacy, which are 2.90 and 2.98, respectively, are considerably lower than the corresponding means of students studying chemistry and computer technology, which are 3.22 and 3.52.

Table 7 shows the variance analysis for our study that illustrates how the cumulative grade point average (GPA) affects the research concept

Variable	Category	Mean	St. Deviation	N
Improve PTK	60 - 67.9	3.96	0.506	15
	68 - 75.9	3.76	0.481	82
	76 - 83.9	3.82	0.497	173
	≥ 84	3.68	0.565	155
Impact PTK	60 - 67.9	3.44	0.84	15
	68 - 75.9	3.23	0.767	82
	76 - 83.9	3.24	0.749	173
	≥ 84	2.78	0.719	155

Impact PTK is significantly affected by the cumulative average (F=10.575, p=0.000–0.05). Least Significant Deference (LSD) test post hoc comparisons show that the mean of students with cumulative averages between 60 and 67.9 and more than or equal to (84) is 2.77, which is noticeably lower than the mean of students with cumulative averages between 60 and 67.9, which is 3.45.

IV. DISCUSSION

A Pearson product-moment correlation coefficient was calculated to determine the relationship between the pedagogical technology knowledge components (pedagogical knowledge, knowledge of mathematical content, lecturers' confidence in using technology, lecturers' beliefs about the value of technology, and technology instrumental genesis) and PTK itself. Except for the understanding of the mathematical content component, which was connected exclusively to pedagogical technology knowledge, all components had a positive connection. Keep in mind that the r value denotes a weak correlation between two variables when it is between 0.3 and 0.5, a moderate correlation between 0.5 and 0.7, and a high correlation between more than 0.7.

Except for the understanding of the physical content components, where a somewhat significant connection was discovered between the said component and pedagogical technology knowledge, Pearson's correlation revealed substantial positive correlations between the pedagogical technology knowledge as a construct and the other components of pedagogical technology knowledge. Except for instructors' confidence in employing technology and technology instrumental genesis, which exhibited a strongly positive association, it also indicated weak to moderate relationships between the various pedagogical technology knowledge components [13].

We created a model for predicting physics lecturers' pedagogical technology knowledge based on their pedagogical expertise, personal attitudes about the utility of technology, confidence in utilizing technology, technological instrumental origins, and understanding of mathematical content using multiple linear regression analysis. Basic descriptive data and regression coefficients are displayed in Table 2. The predictor factors all demonstrated significant ($p<0.01$) partial impacts on pedagogical technology knowledge, like in the previous column. According to the Standardized Coefficient Beta Column, the largest influences on pedagogical technology knowledge were the instructors' confidence in using technology and the role that technology played in society. The numbers in the T column demonstrate that, for the most part, these outcomes were not random. The impact of seniority, employment position, and technological integration degree on the pedagogical technology knowledge scores was also investigated in this study. The current study examines whether instructors' pedagogical technology knowledge considerably altered as a result of their involvement in a Community of Inquiry pedagogical development program. Except for the understanding of the mathematical content components, statistical analysis revealed considerably higher means for pedagogical technology knowledge and all of its components following participation in the pedagogical development program. These findings back up Thomas and Palmer's [9] recommendation to build a Community of Inquiry pedagogical development program to enhance instructors' pedagogical technology knowledge. These findings seem to suggest that the majority of pedagogical technology knowledge components may be changed by technology integration expertise, which is an intriguing discovery that requires more investigation. These findings are consistent with those of Baya'a et al. [5], who looked at how instructors developed their TPACKs as a result of a training program. Baya'a and others [5]. We investigated if background factors impacted how pedagogical technology knowledge components developed among participants in a Community of Inquiry pedagogical development program. The results for seniority revealed that instructors with more than ten years of experience considerably outperformed lecturers with a seniority of 10 years or less in terms of their scores for lecturers' confidence in utilizing technology and technology's instrumental origins. The findings demonstrated that degree of seniority and prior technological integration had a substantial impact on the creation of pedagogical technology knowledge components [15]. These findings are in line with earlier research that revealed that these background factors are crucial for instructors' expertise and knowledge growth [6].

The current study looked at how lecturers' knowledge growth as a result of taking part in the Community of Inquiry program was impacted by the job status background variable. There hasn't been much research done on how work position affects technology integration [7]. This background variable had no discernible impact on the growth of the participating instructors' expertise, according to our research. This may be connected to what Lavicza's [8] experiment discovered, which indicated that the personal traits of mathematics instructors had an impact on their use of technology. These results demonstrate that computer competence did not affect the instructors' usage of technology, even though computer proficiency may be associated with the job status variable [14].

V. Conclusion

PTK development happened through utilizing instructors with high PTK levels whose involvement is beneficial to the community, in accordance with the findings of the current study. The findings also revealed that "beliefs regarding the importance of technology" had a smaller starting sample size among senior instructors and fewer lecturers overall. Perrotta's [9] conclusion that lecturers' evaluations of technology's advantages are more impacted by institutional variables than by individual quality is supported by the same degree of development of less and more senior instructors

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