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Influencing postgraduates' cognition in research methodology via active-interactive PowerPoint-based learning strategy

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ABSTRACT

The rationale of this study was the paradigm shift due to the integration of the educational research methodology course into the curriculum of mathematics postgraduates. However, in most literature reported for postgraduates of education, social, and other science disciplines, who have often enrolled for it, the pedagogics of these curricula have not yet appropriately embedded in the content in a well-structured manner. Because postgraduates poorly conceived research methodology theories, they have been highly challenged in executing their research projects. This study aimed to examine the influence of the active-collaborative PowerPoint-based approach on postgraduates' cognitive knowledge progress in achievement tests and writing and peer presentation skills on open-ended tasks. The mixed methods in a one-group pre-/post-test pre-experimental design were used. Data were collected using the five-point Likert scale questionnaire, achievement test and open-ended questions and analyzed through descriptive statistics, paired samples t-test and thematic analysis techniques. The findings reveal that the active-collaborative learning strategy highly contributed to postgraduates' progress in cognitive performance on the achievement test as there was a statistically significant difference between post-test and pre-test scores; $t(33)=17.3$; $p<0.05$; $\eta^2=0.9$. Postgraduates' conception, understanding, justification, and discourse towards writing and peer presentation on open-ended tasks were not substantial.

Keywords: active-collaborative learning, cognition, postgraduates, PowerPoint-based learning, research methodology

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INTRODUCTION

The human-beings have come to live on earth with a more developed nervous system that distinguishes them from other animals (John & James, 2006, p. 3). However, in ancient times they experienced the natural, physical and social world through their sense organs. They practiced every-daily life in a very traditional way, essentially never involving any scientific knowledge. Their approaches entirely linked with dogmatic religious beliefs called conventional approaches. That, let alone gods furnish people with a livelihood they could even manipulate the sun, stars, wind, rain and lightning at their whim. Abuse their power and extensive preaching, medicine men or priests influenced ancient people in such a way that they are unable to update themselves with the dynamic world. Consequently, the conservative life-style hindered them the search for new scientific knowledge or truth for many centuries.

As time gone in many centuries, human beings became enlightened and then began to think about conducting research in academia, other professions, and careers to make their life easier (Cohen et al., 2018, p. 5). Still, they entirely relied on observation and experience about orders and trends that occurred in the universe. This time was an indicator for the beginning of scientific research. During this time also, their research endeavors had to agree with the doctrines of religion; otherwise, they were often punished and even put to death to any demonstrated disruption. This era was when the pragmatism perspective flourished for which the subjective reality highly dominates scientific inquiry.

To complement the pragmatism paradigm, the first objective/deductive method, a logical approach to reasoning, was introduced by Aristotle and the Greeks (Cohen et al., 2018, p. 6; John & James, 2006, p. 4). The deductive method had also been under the influence of religious dogma. The deductive method Cohen et al. (2018, p. 6), John and James (2006, p. 4), and Soiferman (2010) refers to that at the outset it is driven by hypothesis/theory in the proposal stage, and then tested in the specific application during thesis stage, whether the collected data would support or not support it. It played a vital role in the development of modern problem-solving.

After long years, Cohen et al. (2018, p. 6) and John and James (2006, p. 4), the first time Francis Bacon proposed the inductive method to free the limitation of the deductive method. An inductive method Cohen et al. (2018, p. 6), John and James (2006, p. 4), and Soiferman (2010) refers

to the inquiry conducted to generate a theory or theories in the findings, by taking an in-depth understanding of the natural, physical, and social world based on evidence of many specific observations from the beginning to the end of research.

Since the nineteenth century to date, human beings have paid several efforts and sacrifices to transform the conventional into the scientific approach to research, which is a combination of the deductive and inductive methods. During this time Sheikh and Bibi (2009) as the tertiary education has been expanded more than ever before worldwide. the scientific approach has become compulsory for undergraduates and postgraduates engaged in various disciplines. Therefore, this evidence-based information reminds us of an investment of great effort and time is required of all instructors and learners to have an in-depth understanding of the research methodology course. Consequently, the better knowledge of it undergraduates and postgraduates have acquired in the mainstream class, the more successful they would become applying the theoretical, conceptual and technical aspects in their actual research projects.

However, literatures reported the challenges that most educational and social science undergraduates and postgraduates have faced in the instruction due to the use of inappropriate learning strategy. But this learning challenge has been more critical to pure science postgraduates. As Mishore and Abate (2023) explored, pre-service science teachers in teacher education college have confronted with the difficulty of conducting research projects. One of the main reasons is that the learning strategy instructors used has not allowed them to effectively gain the skill and knowledge of the research methodology course, which requires higher-order thinking.

Other educators and researchers have also pointed-out the roots of learning challenges along with possible remedies based on empirical evidence. As Saeed and Al Qunayeer (2021) examined, students' attitudes towards the subject matter and instructors' modes of delivery are some of the main challenges. They also tried to evaluate several active learning methods used by different researchers and the strategies grounded on them as means of pedagogics. In their own right, they implemented various active learning methods to alleviate the learning challenges. They found that postgraduates developed self-confidence, progressed on assignment work, appreciated the instructor's teaching method, and expressed positive views as better learning experiences. They recommended a pre-test-post-test experimental design with tests/grades that measure learners learning outcomes used as data collection instruments. They also suggested that the intent of future study should be to determine the extent to which instructors' use of similar active learning methods in other contexts is effective or not.

In the study of Saeed et al. (2021), exposing postgraduates to several learning practices, which is quite similar to the active learning methods used by Saeed and Al Qunayeer (2021) enhanced their learning challenges. Integrating research proposal writing in their study was also an important learning environment in gaining conceptual, procedural and technical skills. Because research proposal writing allows learners interaction, reflection and feedback and enable them to engage in problem identification; and objective and research question/hypothesis construction. Akhmetov et al. (2016) confirmed that postgraduates could overcome the difficulties of thesis work through advanced preparation in a research methodology course. They succeeded in organizing experimental work procedures by exposing learners to the pedagogical conditions of which the active learning methods ease their understanding of the various research methods notions. The research recommendation by Saeed and Al Qunayeer (2021) supported these arguments.

According to Daniel et al. (2018), postgraduates (PhD and MSc) had limited knowledge on whether research methodology is a discipline or a less discipline. They also had information gaps in the pedagogy practices. Similarly, Kilburn et al. (2014) observed the underdevelopment of the pedagogical culture compared to other disciplines in the research methodology course. That is one of the predominant challenges in social science research methods instruction in higher education. Daniel et al. (2018) explored much learning and choosing research methodology course challenges as conceptual, procedural and technical problems.

To mention some of them: the scope of the research methodology course was not delimited, and the content was not relevantly detailed. There was no well-developed institution base standardized curriculum as a matter of not viewing it as a discipline. Instructors lack skills in connecting theory with practical instances and developing the right research questions. Because of this, learners have poor knowledge and justification for selecting and using appropriate paradigms (quantitative, qualitative, and mixed) for their research project. They do not have a common understanding of basic terms and concepts in research methodology. They usually associate it with mathematical and statistical knowledge. Conducting a critical literature review to cover the breadth and depth, the problem of aligning research methods and analysis of data, and choosing research methods, like sampling strategy and research methodology, are the other challenges for postgraduates to be good researchers and instructors (Kilburn et al., 2014).

Furthermore, Nind and Katramadou (2022) synthesized literature from studies conducted in 2014-2020 in different countries. Many were from the USA, next from Europe and a few from Asia, like China and Malaysia. One of the learning challenges identified in social science was that the lessons in the research method have not consistently offered to undergraduates and postgraduates. It means most instructors emphasized qualitative research paradigms. Some others concentrated on delivering a quantitative approach. Very few delivered stressing mixed paradigms, research design, and other aspects of research methodology. The pedagogical culture (approach, strategy, tactic, and tasks) in the teaching and learning of research methodology was at a low level of development. Generally, the pedagogies have been under-researched (Kilburn et al., 2014; Lewthwaite & Nind, 2016). They rarely involved active, experiential, and student-centered learning and a combination of them in social science research methods. In the COVID-19 pandemic era, these methods have highly supported online teaching. As Nind and Katramadou (2022) suggested, researchers always need to be encouraged to review research conducted on online learning of research methods using active, experiential, and student-centered learning tactics as a pivot.

Lewthwaite and Nind (2016) conducted a thematic literature review. The review emphasizes social science research methods instruction based on data from responses to interviews, focus groups, dialogic, and panels rather than individual expert teaching experiences. They found that the pedagogic culture and practice are still in the infant stage of development (Kilburn et al., 2014). The absence of standard national and international university curricula has exacerbated these challenges. As instructors could not access this document in the one national education system, their pedagogical content knowledge has not

been sufficient in helping and capturing learners' interest. However, research method instructors have attempted to use active, experiential and reflective forms of learning. It is to address learners' interests and attitudes.

Indifferent from this review, learning by doing has been distinguished as a better learning strategy for natural science research methods courses. But the research on this was limited. Connecting learners to research (visibility), creating a learning environment for learners' hands-on experience in research, and allowing learners to be reflective on their way of tackling research problems have been recommended for researchers and instructors to work on them in the future as remedies for research methodology learning challenges. Based on the principles and illustrative examples produced in Kilburn et al.'s (2014) and Lewthwaite and Nind's (2016) studies, it is suggested that dialogue and debate in an active, experiential and reflective learning environment could be helpful to enhance pedagogics culture and practice.

Research Questions

1. Do postgraduates' exhibit progressive research methodology knowledge through an active-collaborative PowerPoint-based learning strategy?
2. Do postgraduates are capable of writing on open-ended assignment questions and reflecting in peer presentation?

LITERATURE REVIEW

Active-Collaborative Learning and PowerPoint Presentation

The study of the research methodology course requires postgraduates' high engagement into the learning of nature of science and scientific method. As Phillips et.al. (2022) recommended the use of explicit and reflective instruction could allow them to make deep understanding of the nature of science in their learning and teaching endeavors. These days, the explicit and reflective instruction is essential to promote their creative and innovative power for lifelong learning. To realize this, instructors should have passion seeking and use appropriate pedagogical strategies, which needs to be an active, collaborative and interactive learning has become compulsory in higher education. These strategies should always involve instructional technologies and instructors' prepared learning activities and materials to scaffold active-collaborative learning environments with hands-on experiences.

In this regard, Marciniak (2017) confirmed that the class worksheet and the active learning used were highly helpful for developing learners' mathematical knowledge. In this paper, active learning can be effective if it entertains higher-order thinking and group work. Yimer (2022) verified that transitioning teacher-led discourse by traditional lecture method (TLM) into a blended learning environment as an active learning method could increase learners' roles. Likewise, Gámiz-Sánchez (2017) advised that replacing or complementing TLM with an active-collaborative learning environment could contribute to greater responsibility for learning. In Gámiz-Sánchez (2017) mega research, information, communication and technology (ICT) tools have addressed different learning purposes using their many features. They can substantially enhance educational science learners' active learning experiences. As this study verified, active learning, concept maps, and project-based learning can also increase their awareness, creativity, higher-order thinking, positive attitude, communication and competencies.

In Eison's (2010) assessment and Carr et al.'s (2015) validation study, active instructional strategy refers to a learning approach used in various disciplines involving several learning strategies with comprehensive features to maintain and capture learners' interest, attention, and involvement. Eisen (2010) also affirmed that active learning strategy has many advantages over TLM of which even it can be used by blending with to fill what TLM lacks. This same paper also identified and suggested instructors and learners bear in mind those barriers that hinder the application of it in-class and out-class situations. Nicol et al.'s (2018) findings remind them to cautiously use high-technology-based active learning classrooms as it appears various obstacles in the course of implementation.

Instructors and learners can effectively learn by combining active learning with a group project, PowerPoint slides, and online learning, provided the obstacles are lessened (Eison, 2010). Othman et al. (2017) confirmed the argument that diploma learners had shown a positive attitude towards using PowerPoint presentations by performing well in calculus learning. As one of the remedies, Clinton and Kelly (2020) suggested intervention can improve learners' negative attitudes towards group discussion as an active learning technique. Villarroel et al. (2020) study supported this argument as higher education learners responded by strongly agreeing to a five-point Likert scale perception questionnaire towards intervention in experiential learning. In a comprehensive scale measures study by Carr et al. (2015) on online/active learning, the content validity of the response has created an opportunity for higher education learners to be highly engaged.

Bolliger and Armier Jr (2013) examined an empirical study on the satisfaction of postgraduates with the online/active learning environment while generating audio files. From the analysis of data, it inferred that they were highly involved, connected, engaged, socially interactive and communicant with peers. Roberts (2019) studied a research on images as a medium of instruction for energizing active learning. This circumstance has transformed the higher education passive receivers' situation in large-group TLM into participatory learning. As Arruabarrena et al. (2019) reported, integrating various learning practices within active methodologies like flipped classrooms can generate valuable and reusable content for learners to review. It would help them remember what they missed and concretize the already captured materials with interest and motivation. Most research evidence has often advocated the merits of active-collaborative learning strategies.

Theoretical Framework: Pre-Experimental and Post-Experimental Tasks

Active learning strategies are intrinsically social. They promote learner-instructor/tutor, learner-learner, learner-parent and learner-material interaction. Because of this, most of the theories in this study applied in line with the social constructivism cognitive development learning theory by Vygotsky (1980). According to Vygotsky (1980), in most adult learning cases cognitive knowledge development comes through social interaction with classmates and instructor. Taking Vygotsky's (1980) learning theory into consideration, the following experimental tasks were throughout the study.

Before the pre-test, the researcher prepared two PowerPoint presentations, PPT1 and PPT2. PPT1 contains notes on the research methodology course (Math 4071), which was used as learning material

Figure 1. One-group pre-/post-test pre-experimental design (Johnson & Christensen, 2019, p. 458)

for eight years by updating at the end of every academic semester through 2015-2022. PPT2 consists of basic terms of the same course. At the same time, he developed by adapting of achievement test consisting of 53 multiple-choice, 11 matching and 12 completion items; and 20 open-ended assignment questions for writing and peer presentation. During this same period, 21 five-point Likert scale questions labelled as strongly disagree=1, disagree=2, neutral=3, agree=4, and strongly agree=5 were employed.

On day one class one, the achievement test was administered to pre-assessing the background knowledge of postgraduates, as well as the five-point Likert scale questionnaire to pre-assess their opinion about the course. They responded to the five-point Likert scale questionnaire individually while the achievement test individually and in a group dialogue-base, where six groups were with five students and one group with four students after each continuous session task. On this same day, a softcopy of PPT1 was offered for them as a reading assignment for one week before the instructor/researcher and postgraduates discussed it. Immediately after the completion of PPT1, they directly engaged in PPT2. Around the end of the semester, six postgraduates presented the five open-ended assignment questions for classroom observation. They also sat for post-test achievement tests and submitted their writing assignment questions.

METHOD

The mixed method in a one-group pre-test-post-test pre-experimental design with quantitative and qualitative data utilized in the study shown in **Figure 1**.

Target Population

The target population of the study was the first-year mathematics postgraduates of three batches through 2020 to 2022, who enroll for the research methodology (Math 4071) course in the second academic semester.

Sample and Sampling Technique

Purposive sampling technique was used to select 34 three batches postgraduates, where one of them did not participate during post-test.

Instruments

The researcher prepared a five-point Likert scale questionnaire, open-ended assignment questions for writing and peer presentation, and the adapted achievement test (Mohamed Osman, 2018, p. 16; Sheikh & Bibi, 2009, p. 7) used as the data collection instruments.

Content Validity

As Gay et al. (2012, p. 160) suggested, data collection instruments validated in different contexts could be effective for various research purposes. Accordingly, this study presumed the content of the adapted achievement test with 76 questions in the context of previous research projects. The researcher taught for 28 years. He validated the content of this same test for postgraduates' formative and summative assessment of the research methodology (Math 4071) course through 2015-2022. Moreover, three subject experts evaluated it in the context of the current study. They supplemented four more multiple-choice items in the post-test in it. They assessed the 20 five-point Likert scale questionnaires about the overall language used, order and items coherence. They also added one more question by evaluating its suitability and agreement with the purpose of the study and syllabus.

Data Collection

Achievement test scores, as quantitative data collected from respondents for measuring the statistical significance of the cognitive performance change through pre-test to post-test (Gay et al., 2012, p. 155). Respondents' opinion ratings on a five-point Likert scale questionnaire had used as qualitative data. It was to assess their background affective characteristics towards the course. Writings on five open-ended assignment questions and peer presentations for classroom observation from six postgraduates explored to take an in-depth understanding of the knowledge progress.

DATA ANALYSIS AND RESULTS

Descriptive Analysis

For research participants' undergraduate learning experience towards the research methodology course was paid due consideration. It is to see in the analysis whether or not it had some influence on their cognitive performance in the postgraduate study. 19 (55.9%) postgraduates enrolled for the research methodology course in the undergraduate study. Out of which, 14 (41.2%) postgraduates carried out project work, while five postgraduates (14.7%) conducted research using their basic knowledge and skill. 15 (44.1%) postgraduates did not enroll for the research methodology course in their undergraduate study.

Descriptive statistics results of research participants' opinion rating on a five-point Likert scale questionnaire are depicted in **Table 1**. In **Table 1**, there are 21 constructs grouped into four criteria in the questionnaire. One construct is about the concept of research. One construct is about exposure to the research methodology course in the undergraduate study. 18 constructs are about basic knowledge towards the research methodology course. One construct is anticipating the significance of the research methodology course. Most postgraduates (mean [M]=4.29) responded by agreeing to the concept of research construct. A little bit above one-half of postgraduates (M=3.14) took the research methodology course in their undergraduate study. The agreeing response on their basic knowledge towards this course was moderate (M=2.95). All agreed on the importance of the research methodology course in their future research work.

In the pre-test, postgraduates accomplished the following cognitive knowledge on the achievement test in the research methodology course by way of individual and group performance out of 100.0%. The maximum scores for individual and group performance were the same and equal to 57.50. The minimum score for individual performance was 34.20, while the minimum group performance score was 46.57. The reason for the minimum score progress from individual to group performance was most likely the postgraduates' response through the active-collaborative and interactive discussion in devised instrument. Overall, group cognitive performance scores were better than individual performance scores.

Table 1. Descriptive statistics on postgraduates' affective characteristics (pre-test)

Affective characteristics constructs	M	SD
Concept of research		
I have an overview about the term 'research'.	4.29	0.76
Exposure to research methodology course		
I have not learnt basics of research in my undergraduate course study.	3.14	1.77
Basic knowledge towards research methodology course		
I can differentiate scientific research activity from that of daily life activity.	2.86	1.35
I cannot identify and state research problem statement.	3.29	1.38
I can construct the objective(s) of a research study.	3.00	1.16
I cannot construct the hypotheses/research question(s) of a research study.	3.14	1.22
I can explain the importance of literature review.	3.29	1.38
I am not familiar with positivist, post-positivist, interpretive, empiricist, & etc., philosophical assumptions.	2.43	0.98
I can mention the basic types of quantitative, qualitative, & mixed research methods.	3.57	1.28
I cannot develop data collection instruments such as questionnaire, observation, & interview.	3.71	1.25
I can describe the term sampling, sampling frame, sample, representative sample, & population.	2.86	1.22
I can explain probability and non-probability sampling techniques, & the types under each of them.	2.86	1.07
I cannot explain the difference or similarity among methods, methodology, & research design.	3.14	1.35
I can classify the basic data analysis techniques for quantitative, qualitative, & mixed paradigms.	2.71	1.38
I can define the term research proposal.	3.00	1.53
I cannot develop research proposal.	3.29	1.38
I have worked with statistical software packages for social sciences (SPSS) for quantitative data analysis.	1.14	0.38
I do not have the skill of research report writing.	2.86	1.57
I can use the proper in-text citations and referencing styles in my research work.	3.14	1.07
I am not familiar to publishing research article in appropriate journal.	2.86	1.57
Weighted mean	2.95	
Anticipating significance of research methodology course (Math 4071)		
Math 4071 course can help me for conducting basic/fundamental research project, expected from me after having completed course works.	5.00	0.00

Note. M: Mean & SD: Standard deviation

Table 2. Paired-samples t-test results & effect size value

Variable	Group	n	M	SD	MD	SD-MD	df	t	p	η^2
Post-test score	One	34	82.58	9.30	30.69	1.77	33	17.30	.000*	0.90
Pre-test score			51.88	10.14						

Note. *p<.05; M: Mean; SD: Standard deviation; MD: Mean difference; & SD-MD: Standard deviation of mean difference

Table 2 displays the paired-sample t-test results with effect size value on achievement test scores through pre-test to post-test on the basis of postgraduates' individual performance.

According to Cohen et al. (2018), the results shown in **Table 2** there was a statistically significant difference between the post-test score (M=82.58, SE=1.59) and pre-test score (M=51.88, SE=1.74); t(33)=17.3, p<0.05, 95% CI [27.09, 34.29]. The effect size value η^2=0.9 represents a strong effect.

Results Through Thematic Analysis

The five open-ended questions used for writing assignments and peer presentations in classroom observation are the following.

1. Brief why different people (researchers) provide different meanings to the concept of 'research/scientific research.'
2. Explain about the term 'science' and 'philosophy', and their relationship with the term 'research'.
3. Explain why the need to conduct research by researchers in different settings.
4. Explain what a researcher needs to do at the outset of any research process.
5. Explain why the need to define a research problem and delimiting it.

The thematic analysis on postgraduates' reflections in classroom observation towards these questions were summarized.

Most participants presented all the five open-ended questions with poor reflections and discourses by merely adhering to reading the written material, which is not advisable and convincing. However, student PGR2 nicely reflected overall questions in the peer discussion. Some of the reasons for their unsatisfactory verbal performance were poor language proficiency, difficulty to conceptual understanding, lack of skill to procedural and technical knowledge and problem of justification in dialogues requiring strong logical reasoning.

The thematic analysis on postgraduates' writings were synthesized based on the dominant themes involved in their responses.

Student PGR1 answered question 1 by merely viewing research as the field of study in which researchers are engaged. The availability of resources at the given time led many educators and scholars to construct different meanings of the term research. He simply wrote the definitions developed by educators and scholars.

PGR2 responded to question 1 as researchers could draw different meanings to the concept of research based on the choice of data collection and analysis techniques they can make.

PGR3 and PGR4 responded to question 1 as a researcher's perception of research depends on his or her knowledge of the meaning

of the scientific method. They viewed research and the scientific method are closely related.

PGR5 answered question 1 as the concept of research is wide and occurs everywhere.

PGR6 responded to question 1 as anybody can define the concept of research as own attitude.

Thematic analysis 1

Almost all learners could not conceptually understand question 1. They provided poor justification for their answers. They demonstrated difficulty conceptually understanding the question. PGR1 entirely depended on others definitions instead of he was expected to define research in his own words. PGR2 was not able to identify the basis for educators or researchers in giving different meanings to research. PGR2, PGR3, and PGR4 had lack of explanation on conceptual questions with understanding. PGR3 and PGR4 tried to relate research and scientific method without mentioning that scientific method can be used as tools in the research process from the beginning to end. As compared to other students, answers of PGR5 and PGR6 had no substance in connection to the conceptual, understanding and justification aspects of question 3.

PGR1 explained the terms 'science', 'philosophy' and 'research' and their relationship between them as philosophy refers to a study/domain with many branches. It makes use of reasoning, questioning, and analysis. It explains situations and find answers. It does this using logical argumentation. It originated from the Greek word 'philosophy'. It helps us to understand the nature and relationship between man and existence. It involves subjective and objective questions and generating them. It creates knowledge through thinking applied to many extensive areas of the discipline. It is a system of a researcher's thoughts and follows to which to obtain a new and reliable knowledge about research. It forms the basis of research through the appropriate choice of research strategy, formulating the problem, data collection, processing, and analysis.

Science does the same thing but utilizes empirical data. It comes from the Latin word 'scientia'. It is a defined study concerned with natural phenomena. Only objective questions can be related to it. It takes answers and proves them as objectively right or wrong. It creates knowledge by observing, applying and studying the logic of facts and diligent research through experimentation in the physical or natural world. It has different fields and topics to do research with. Research is the systematic study of scientific materials or evidence to establish facts and reach new conclusions about that science.

PGR2 answered question 2 as philosophy is a way of learning about ourselves and the world. It cannot provide the answer to all questions without research. Science does the same thing. Philosophy is an academic discipline. It studies the fundamental nature of knowledge, reality and existence.

Science refers to intellectual and practical activity encompassing systematic study of structure and behavior of physical and natural world through observation and experiment. Scientific revolution completely shifts that science looks at the world through scientific research. Scientific research orients towards the discovery of relationship that exists among phenomena of the world. It does not progress towards truths. But dogma and old theories influence it. Science studies things by following certain agreed-upon norms and practices, reality and existence (philosophy), and structure and behavior.

PGR3 and PGR4 answered question 2 as philosophy is a critical analysis of fundamental assumptions or beliefs. It is a system of values by which one lives and a "love of wisdom". Science includes any systematic or carefully done actions to answer research questions or meet other needs of a developing research domain. It involves the application of the scientific method. It does not accept face-value taken-for-granted knowledge. It uncovers and justifies descriptions and explanations of people, groups, and the world around us.

PGR5 and PGR6 answered question 2 as philosophy is a rational attempt to look at the world as a whole. It is a set of views or beliefs about life and the universe. Science is systematic and interpretive that builds and organizes knowledge through explanation and prediction. The terms science and research are used together often or sometimes interchangeably. The term science, philosophy and research are almost the same. All are the process of thinking.

Thematic analysis 2

PGR1 explicitly and concisely explained the three terms, particularly on philosophy and science. He also demonstrated satisfactory understanding by sufficiently describing the relationship between the three terms. Overall, he could conceptually understand this question. PGR2 had some conceptual understanding. He was not able to sufficiently explain the relationship between the three terms. PGR3, PGR4, PGR5, and PGR6 entirely depended on the reading materials used for their reading. They were unable to write answers in their own words. They could not mention the relationship between the three terms. They missed parts of the instruction in the question. They had partly conceptually understood this question.

PGR1 responded to question 3 as research is conducted in different settings to understand a phenomenon, situation, or behavior under study. It is also to test theories and develop them based on existing ones. It is to answer the 'wh' questions.

PGR2 answered question 3 as it is to describe the physical, social or experimental context. The interpretation may heavily depend on these environments. A laboratory experiment setting is more controlling the environmental variables.

PGR3, PGR4, PGR5, and PGR6 answered question 3 as it is to find a solution, make life easy and explore ideas.

All participants answered question 4 by mentioning most of the steps involved in the research process. These are problem identification, reviewing the literature, setting research questions, objectives and hypotheses, choosing the study design, deciding on the sample design, collecting data, processing and analyzing data, and writing a report.

Thematic analysis 3 & 4

All of them could not conceptually understand question 3. They provided poor justification for their answers. They demonstrated difficulty conceptually understanding the question. As compared to answers to the preceding two questions, they irrelevantly answered question 3 and question 4, with no substance in connection to their conceptual, understanding and justification aspects. All in all, they missed the instruction in the question.

PGR1 responded to question 5 as a research problem is a specific issue, difficulty, contradiction, or knowledge gap that we will aim to address in our research. Practical problems contribute to change. Theoretical problems expand knowledge. Research delimitation means

focusing on concrete terms in our area of interest, specifying their scope, and determining their limits. That is to advance the research problem from an ideal situation to a concrete reality that is easy to handle.

PGR2 answered question 5 as defining a research problem is essential to acquaint the reader with the topic studied. It is to associate the research problem with a particular context and to provide the framework for reporting the results. It also specifies all the aspects necessary to answer the research question. It establishes the target population, time and space for research.

PGR3 and PGR4 answered question 5 as every research plan is unique in itself and has unique research problems. There was an old saying that "a problem well defined is a problem half solved". A research problem means a systematic way of asking and answering research questions. Delimitation of the study is a section, where we exactly show the boundary of our research. It determines what aspects of the topic should be incorporated and where they should be employed.

PGR5 responded to question 5 as research defines a research problem. Specifically, delimiting a research problem is done to address all the aspects that are necessary to answer the research question. Delimitation refers to the boundaries of the research based on the researchers' decision of what to include and exclude. It narrows the study to make it more manageable and relevant to what we are trying to prove.

PGR6 answered to question 5 as the problem investigated must be defined unambiguously to discriminate relevant data from irrelevant ones. A well-defined research problem enables the researcher to be on the right track, whereas an ill-defined problem may create hurdles. Delimiting a problem can also be made on some variables, the study area, on size of the sample considering the time, energy and money, the best method possible, and the best tool for measuring the variable.

Thematic analysis 5

PGR1, PGR2, PGR5, and PGR6 had some knowledge conceptually understand question 5. PGR1 and PGR2 provided poor answers without any justification as to the importance of defining and delimiting research problem. PGR5 and PGR6 supplied better conceptually understand with some justification as to the importance of defining and delimiting research problem. PGR3 and PGR4 had a better knowledge conceptually understand and justification in answering question 5 as compared to their other writings and reflections. Overall, all of them demonstrated difficulty conceptually understanding the question.

DISCUSSION

These days, science and mathematics curriculum developers in worldwide universities have paid great attention to the research methodology course. Despite this, a curriculum for it as a compulsory course has been designed for mathematics undergraduate and postgraduate studies. However, even for education and social postgraduates, the curriculum of this course was not rich in concepts, procedures, techniques and pedagogics. So, it has not been taught in an organized and structured way.

As a matter of this fact, this study intended to influence postgraduates learning challenges of the research methodology course through an active learning strategy. The concepts of research ideas, critical literature review, paradigms, approaches, theories, philosophical perspectives, methodology, data analysis techniques and research report writing were a few for the point of focus. To meaningfully address this, undergraduate background towards research methodology, affective characteristics by the five-point Likert questionnaire and cognitive knowledge through achievement tests and open-ended questions have been examined.

The findings look like the following. A bit above the average number of postgraduates (M=3.14, 55.9%) enrolled on the research methodology course in their undergraduate study. During this time, most of these (41.2%) carried out project work, while a few (14.7%) worked on research using their basic knowledge and skill. 15 (44.1%) postgraduates did not enroll for the research methodology course in their undergraduate study. In the pre-test, the maximum scores for individual and group performance on the achievement test were the same and equal to 57.50. The minimum score for individual performance was 34.20, while the minimum group performance score was 46.57. The reason for the minimum score progress from individual to group performance was most likely the use of the active-collaborative and interactive discussion in the devised instrument. Overall, group cognitive performance scores were better than individual performance scores.

In the post-test, most postgraduates (M=4.29) responded by agreeing to the concept of research construct in the affective questionnaire as they could provide something that explains the term. The agreement response on their basic knowledge towards this course was moderate (M=2.95). All agreed on the importance of the research methodology course in their future research work. In the same session, there was a statistically significant difference between post-test and pre-test cognitive knowledge performance scores in the achievement test, $t(33)=17.3$; $p<0.05$; $\eta^2=0.9$.

Consequently, the devised learning circumstances, such as examining the backgrounds of postgraduates, allowing them to work individually and discuss in the group on achievement tests during pre-test and assessing their writings and observing peer presentation open-ended questions through the active-collaborative PowerPoint-based approach have contributed to the highest cognitive knowledge performance. This outcome, particularly on concept learning, agrees with Marciniak (2017), Othman et al. (2017), and verified what Akhmetov et al. (2016), Clinton and Kelly (2020), Eison (2010), Gámiz-Sánchez (2017), Kilburn et al. (2014), Lewthwaite and Nind (2016), Saeed & Al Qunayeer (2021), Saeed et al. (2021), and Yimer (2022) suggested. However, postgraduates' conception, understanding, justification and discourse in writing and peer presentation on open-ended assignment questions were not remarkable. This result partly agrees with Saeed and Al Qunayeer's (2021) findings. It implies that learners, researchers and instructors are required to be more engaged in these learning challenges in the future.

CONCLUSIONS

The research methodology is an essential course for mathematics undergraduates and postgraduates. But it is a challenging course. It involves proposal and thesis projects, which require a lot of writing skills with logical reasoning. Thus, instructors should always be motivated to seek and use appropriate pedagogical strategies to maintain and capture their interest, attention and involvement. One of

the learning strategies able to realize profound forms of collaboration and engagement and replace autonomous learning is an active-collaborative learning strategy. The findings of this study are evidence that the active-collaborative PowerPoint-based learning environment greatly benefitted postgraduates. Consequently, instructors should always be encouraged to explore active learning environments with different practices and strategies, potential to positively influence undergraduates' and postgraduates' writing tasks in research methodology courses as well as their research projects.

Recommendations

Based on the findings of this study, the researcher would like to advise instructors and researchers to be able to design interventions. They should also be encouraged to devise new active-collaborative learning strategies integrated with appropriate instructional technology. Overall these could likely serve undergraduates and postgraduates successfully tackle their writing assignments knowledgeably in their future teaching-research projects in research methodology courses. Instructors should be encouraged to discover active learning strategies that can entertain learners' context and their prior knowledge. Postgraduates should always learn basic notions of research methodology in their degree program studies. The Ethiopian education system is currently introducing this curriculum for public universities.

Undergraduates and postgraduates must enroll for the research methodology course as a compulsory course to be innovative and creative in their lifelong learning. Postgraduates should always be industrious while studying the research methodology course, which requires them great effort and time. Blending various learning practices with instructional technology in higher education should be inevitable for effective learning in this modern era. College/university instructors and pre/in-service teacher educators should have the skill of active-collaborative and interactive learning strategies integrated with instructional technology developing well before mainstream classes. Applying active-collaborative and interactive learning strategies integrated with instructional technology can substantially improve learners' conceptual understanding and procedural fluency.

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