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INTRODUCTION TO RESEARCH

1. **Name of the group and details of the exercise being submitted.**

Power Rangers

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Chapter 2 Research Gym Question 1 Mohanan & Mohanan (2021)

Have you heard of mathophobia? This is what Wikipedia says:

“Mathematical anxiety, also known as math phobia, is anxiety about one's ability to do mathematics. It is a phenomenon that is often considered when examining students' problems in mathematics. Mark H. Ashcraft defines math anxiety as “a feeling of tension, apprehension, or fear that interferes with math performance” ...The academic study of math anxiety originates as early as the 1950s, where Mary Fides Gough introduced the term mathemaphobia to describe the phobia-like feelings of many towards mathematics... Ashcraft suggests that highly anxious math students will avoid situations in which they have to perform mathematical calculations. Unfortunately, math avoidance results in less competency, exposure and math practice, leaving students more anxious and mathematically unprepared to achieve.”

https://en.wikipedia.org/wiki/Mathematical_anxiety Given that the phenomenon of math anxiety is widespread, one might entertain at least three hypotheses about it: Hypothesis I: Learners suffer from math anxiety because of their own and others' impression that they lack the capacity for mathematical thinking. [How legitimate is that impression?] Hypothesis II: Math anxiety is the result of poor quality teaching of mathematics. [If a math teacher humiliates learners when they fail to give the 'correct' answer, they associate math with boredom, pain, and fear.] Hypothesis III: The anxiety is not about real mathematics which can be joyful, but about what is taught as math in textbooks and classrooms. Consider the following possibilities: Of the three hypotheses, a. One (it could be any) is true, and the other two are false. b. Two are true, and one is false. c. All of them are true. d. None of them is true. Write a research plan to find out which of these four possibilities is the case. Here is what you need to do for this. Think carefully about the question, then describe in a page or so what kind of data would help you to engage with the question, and how you would gather the data.

2. Write up on Chapter 2

Reading for Understanding

a) Read the whole article/book once, and summarize the gist of it in a single sentence. Someone who hasn't read the book should understand from that sentence what YOU think the book is all about (the essence - the core message - of the book.)

According to Mohanan & Mohanan (2021), research is not a linear process. While formulating a research, various methodological strategies such as critical thinking, justification, defense, data collection, findings, predictions, premises are used to examine all the possibilities in any given field.

b) Now, expand that sentence into a paragraph. Again, in a way that someone who hasn't read the book should get what YOU think is the essence of the book.

In order to build a methodology, we need a research question. However, the question frequently changes as the process is thought through, planned, and put into practice. It's possible that the question that was actually considered has changed significantly from the one we started with by the time we report our findings to the academic community. Because of this, creating a research proposal may include several iterations of the process, starting with the formulation of the research topic and ending with the development of a conclusion. Based on the answers developed in the Chapter One, such a way that the concepts of a research question and a research problem are equivalent, but viewed from slightly different perspectives, in this chapter we study how the strict linearity of a research is removed in order to shed light on the idea of research involving several cycles. This chapter introduces us to the role of critical thinking in various stages of the process.

c) Formulate a set of questions such that the summary of the book would be the answers to those questions.

1. Is Research a linear process?
2. What is the difference between a research question and a research problem?

3. What is the difference between an answer and a solution?
4. What are the components of Methodological strategies?
5. What is a theory?
6. Are the methodological strategies used in Mathematics same as those used in Sciences?

d) Drawing upon 1 (a)-(c), write a 2-3 page review that is worth publishing, summarizing what the article/book says, with comments on its strengths and weaknesses.

In Chapter Two: Methodological Strategies by Mohanan and Mohanan (2021), we begin by seeking the answer to the question 'Is Research a linear process?' The process of conducting research is not linear. Having a research question is necessary before we can develop a methodology of going about solving the question. However, when the process is considered, organized, and put into action, the question usually is altered. By the time we present our findings to the academic community, the question that was actually taken into consideration may have drastically changed from the one we began with. Because of the fact that the question might change, creating a research proposal may include several iterations of the process, starting with the formulation of the research topic and ending with the development of a conclusion.

We also understand the difference between a research question and a research problem; and also the difference between an answer and a solution. A research question communicates what we don't know but want to learn in light of what we do. An area of ignorance is transformed into knowledge by the solution. An unfavorable situation is described by a research problem. A solution transforms that bad state into a desirable one.

In this paper Mohanan and Mohanan (2021), state that the methodological approaches used in scientific and mathematical research differ substantially. One of them is related to the fundamental characteristics of knowledge in these two fields. Mathematics aims to understand the nature of imagined worlds that are logically consistent while science seeks to understand the nature of the world that we happen to live in. The researchers' imagination is used to conceptualize and build the worlds of rigid vs. non-rigid surfaces, gradient vs. discontinuous surfaces, and flat vs. curved surfaces. The mathematician creates such worlds and then enquires what is true in each of these worlds.

It was discovered that if we make one assumption about what a straight-angled triangle is, then the assertion that such a thing cannot exist is true, but if we make another assumption about what a straight-angled triangle is, then the statement that such a thing exists is true. Since mathematical truths depend on the axioms and definitions of the specific mathematical universe in question, this is not a logical contradiction: what is true in one world may not be true in another world. Science, on the other hand, is concerned with the specific reality in which we live, thus this is not the case. And logical contradictions are forbidden in any world. According to Euclidean Geometry, Newton assumed that the earth is flat. However, in contrast, Einstein modeled our world using spherical geometry and believed that gravity produced the curvature of space. Given the proof and reasoning offered by Einstein, we now hold that Newton was mistaken.

In conclusion, this chapter gives us a deeper understanding of formulation research by confirming that it is not a linear process, but has several cycles of Methodological strategies that

help in coming up with a detailed explanation considering the thorough study of a specific area of that research.

Reading for Deep Comprehension

a) Read the book again, this time connecting one or more (but not more than five) central ideas (concepts and statements) of the book to what ALREADY exists in YOUR mind (the memory of your experiences, your understanding of what you think you already know, ...).

Central Idea : According to Mohanan and Mohanan (2021), a research problem articulates an undesirable state of affairs.

Existing Idea : In a research problem, we take up affairs or issues that require a solution. It is more of a contradiction or gap in knowledge that challenges the mind of the researcher. For example, "why does it not rain in the desert?" is a research question but "why is it not raining in tropical regions?" is a research problem. In a research problem the researcher looks for the cause and effects of the problem and plans to come up with a set of possible and logical ways to tackle the problem.

Central Idea : A defense is the response to the question "why should we accept your conclusion as part of academic knowledge?".

Existing Idea : Defense in research is presented in front of the academic professionals who further evaluate the purpose and quality of the research work. A researcher presents their thesis and the academic professionals cross-examine the thesis, arguments and evidence before approving the thesis as legitimate.

Central Idea : The term 'data' refers to the pieces of information, qualitative or quantitative, collected through observation.

Existing Idea : Data is the information or statistics collected by people over a period of time through various surveys, observations and questionnaires. It is the piece of information that is collected and compiled together to draw conclusions or theorize an observation. It can be presented as evidence to factualize the theory. Data can be of various types like economic data, historical data, population literacy data, family data, temperature data, etc. Knowledge is the awareness of the environment that some entity possesses, whereas data merely communicates that knowledge. The trends of changes, similarities or differences across people and countries are measured through the collected data for further research.

Central Idea : A claim needs to be supported by a legitimate argument to be a part of academic knowledge.

Existing Idea: A claim is an argument one presents forth based on their knowledge, experiences and observations. Claims are potentially arguable. For instance, "Romantic poetry is the best form of poetry" is a claim, while "I don't like poetry" is not. The rest of the world can't really dispute whether I like poetry or not, but whether romantic poetry is the best or not can be argued. Logical arguments and a set of evidence can be used to justify a claim as truth.

Central Idea : Examining the legitimacy of an argument is called 'interpretation' in research.

Existing Idea : Interpretation is the understanding and exploration of the concept. It involves organizing and comprehending the underlying concepts and theories in a research problem, which helps the researcher to draw follow up arguments and conclusions. It is the search for broader meaning which throws light on the true meaning of the material. The researcher is able to understand the abstract principle behind his findings and check for the reliability of the research through analysis.

b) Ask questions of the form "What is X?" where X is one of the concepts in (2a). Your answer should shed light on the similarities and differences between these concepts and related concepts and analogous concepts are unified. (e.g. what is 'linear' such that 'lines' in your experiential knowledge, 'linear' in linear correlation, 'linear' in 'linear algebra' and 'linear' in 'non-linear dynamics', etc form a single concept?)

What is a research problem?

A research problem is a statement about an area of concern, a condition to be improved, a difficulty to be eliminated, or a troubling question that exists in scholarly literature, in theory, or in practice that points to the need for a solution, i.e. meaningful understanding and deliberate investigation.

What is defense in research?

Defense in research is a set of arguments, evidence and proof submitted by the researcher to the academic community in favor of their work so that the academic community accepts the research

work as part of academic knowledge. The purpose is to share the results of the study and to demonstrate to the academic community that the reseaĵrcher has done work of sufficient quality and the researcher can be considered a knowledgeable expert in the field.

What is data?

Data is a collection of information and values from which inferences are drawn. It is collected through a series of observations over a period of time. It is both quantitative and qualitative as it can be measured in numbers and values. It is compiled together for analysis which helps the researcher to draw conclusions about the theory. Data becomes an evidence for knowledge in a research problem when the information collected is approved by the academic community.

What is a claim?

A claim (“Argument: Claims, Reasons, Evidence” 2015) is usually a main idea, often called an argument or a thesis statement, backed up with evidence that supports the idea. Claims are statements about what is true or good or about what should be done or believed. The claims should be backed up by logical arguments and evidence for it to become knowledge.

What is interpretation in research?

Interpretation refers to the task of drawing inferences from the collected facts after an analytical and/or experimental study. Interpretation is the device through which the factors that seem to explain what has been observed by the researcher can be better understood. Interpretation questions the legitimacy of the research and it provides a theoretical conception of the topic which can serve as a guide for further research.

Reading for Knowledge

a) Articulate the central claims of the article/book (a single primary claim, with two or three secondary claims if needed. Not more than three.)

The central claim of this article is that research is not a strictly linear process. Research also involves several things like, the evolution of research questions, the distinction between research questions and research problems, the importance of critical thinking and justification in presenting research outcomes. It is necessary to define key terms and narrow down the scope of research questions to facilitate the research process.

b) Identify and articulate the arguments (proof / rational justification /evidence and arguments) that the author offers in support of the claims.

The authors KP Mohanan & Tara Mohanan support the claim that research is not a linear process by demonstrating how research questions evolve as methodologies develop. They also differentiate between research questions and problems, emphasizing the non-linear nature of addressing both. The author also stresses the importance of thinking carefully, providing reasons, and defining terms precisely. These factors support the idea that research is a flexible and not a straightforward process.

c) Critically evaluate the soundness of the arguments (evaluate the validity of the reasoning and the credibility of the premises).

The argument presented by the author is sound and credible. They accurately highlight the common evolution of research questions, provide a logical distinction between research questions

and problems, and emphasize the importance of critical thinking and justification, all of which align with established practices in research. However, it's important to recognize that research practices can vary across fields, and while these principles generally hold true, there can be exceptions and variations.

d) On the basis of (2), think of additional arguments in support of or against (3a).

Based on the information provided, I accept the central claim in the statement. The central claim accurately describes key aspects of the research process, including its non-linearity, the difference between research questions and research problems, the importance of critical thinking and justification, and the need to define key terms and narrow down the scope of research questions.

e) On the basis of 3 (a-d), decide whether you should accept or reject (or keep on hold) the claims in (3a).

Based on the information provided in A) through D), it is reasonable to accept the central claim made in A) that research is not a strictly linear process, and it involves various aspects such as the evolution of research questions, the distinction between research questions and research problems, the importance of critical thinking and justification, and the necessity of defining key terms and narrowing down the scope of research questions. The supporting information in B) and C) further reinforces the credibility of this central claim. Therefore, you should accept the central claim in A).

3. Write Up Research Gym Chapter 2 Question 1 Mohanan & Mohanan (2021)

Have you heard of mathophobia? This is what Wikipedia says:

“Mathematical anxiety, also known as math phobia, is anxiety about one's ability to do mathematics. It is a phenomenon that is often considered when examining students' problems in mathematics. Mark H. Ashcraft defines math anxiety as “a feeling of tension, apprehension, or fear that interferes with math performance” ...The academic study of math anxiety originates as early as the 1950s, where Mary Fides Gough introduced the term mathemaphobia to describe the phobia-like feelings of many towards mathematics... Ashcraft suggests that highly anxious math students will avoid situations in which they have to perform mathematical calculations. Unfortunately, math avoidance results in less competency, exposure and math practice, leaving students more anxious and mathematically unprepared to achieve.” https://en.wikipedia.org/wiki/Mathematical_anxiety Given that the phenomenon of math anxiety is widespread, one might entertain at least three hypotheses about it: Hypothesis I: Learners suffer from math anxiety because of their own and others’ impression that they lack the capacity for mathematical thinking. [How legitimate is that impression?] Hypothesis II: Math anxiety is the result of poor quality teaching of mathematics. [If a math teacher humiliates learners when they fail to give the 'correct’ answer, they associate math with boredom, pain, and fear.] Hypothesis III: The anxiety is not about real mathematics which can be joyful, but about what is taught as math in textbooks and classrooms. Consider the following possibilities: Of the three hypotheses, a. One (it could be any) is true, and the other two are false. b. Two are true, and one is false. c. All of them are true. d. None of them is true. Write a research plan to find out which of these four

possibilities is the case. Here is what you need to do for this. Think carefully about the question, then describe in a page or so what kind of data would help you to engage with the question, and how you would gather the data.

First, let's take the definition of math phobia that has been provided in the question.

Mathematical anxiety, also known as math phobia, is anxiety about one's ability to do mathematics, where a feeling of tension, apprehension, or fear interferes with math performance. Highly anxious math students tend to avoid situations in which they have to perform mathematical calculations but this avoidance results in less competency, exposure and math practice, leaving students more anxious and mathematically unprepared to achieve.

Now that we're clear about exactly what me mean by math phobia, let's consider the following hypotheses about the phenomenon:

1. Hypothesis I: Learners suffer from math anxiety because of their own and others' impression that they lack the capacity for mathematical thinking. [How legitimate is that impression?]
2. Hypothesis II: Math anxiety is the result of poor quality teaching of mathematics. [If a math teacher humiliates learners when they fail to give the 'correct' answer, they associate math with boredom, pain, and fear.]
3. Hypothesis III: The anxiety is not about real mathematics which can be joyful, but about what is taught as math in textbooks and classrooms.

This leaves us with 4 possibilities,

a. One (it could be any) of the hypothesis is true, and the other two are false.

b. Two are true, and one is false.

c. All of them are true.

d. None of them are true.

The research plan to figure out which of these four possibilities is true, is as follows:

We will work with the assumption that every hypothesis is true and collect data for each hypothesis in its own specific way.

I think Hypothesis I can be classified as a psycho-social issue in the realm of personal life. If the learners suffer from math anxiety because of their own and others' impression that they lack the capacity for mathematical thinking, the root cause must be self-esteem and self confidence issues which must have begun in family spaces possibly since childhood. Anxiety about one's mathematical ability must obviously not have just begun in a vacuum and must be related to one's own thoughts of inferiority/confusion or feeded insecurities from a family member or friend. Given the personal nature that this hypothesis is founded on, I think the most apt methodological strategy to gather data would be a mixture of quantitative and qualitative experimentation

1. Analyzing the subject's examination scores across several tests and several years to study patterns/areas of confusion or difficulty in mathematics. Also through the study of the examination records, figuring out a graph of mathematical performance to locate exactly when the issue arose, whether it was always there, or if it happened after a particular incident(falling sick and missing a lot of concepts and then inability to catch up, personal disinterest with the increasing complexity of work, making a mistake/being slow at mathematical situations in personal life that led to

humiliation or insecurity etc) or an introduction to a foundational mathematical topic that wasn't understood and therefore affected further learning, etc.

2. Personalized questionnaires/or interviews that enquire about the environment of mathematical study (whether it is done alone or with someone from the family, whether family/friends are aware about the anxiety and reference it a lot i.e. unintentional or intentional bullying, casual or abusive affirmations (being physically beaten/ verbally abused regarding mathematical ability) of being labeled as stupid, how much time is allocated to study mathematics, a list of the possible topics of study the subject may have encountered like exponents, sets, algebra, geometry, addition, subtraction etc where the subject can rate their comfort/discomfort with the specific topics on a sliding scale).

I think Hypothesis II is a psycho-socio issue of the public or social domain. Math anxiety as the result of poor quality teaching of mathematics can be verified through the strategies given below:

1. A researcher could be sent to observe the classroom environment to see the teaching methods and environment first hand. They can gauge the levels of interaction, engagement and sensitivity that exists in the environment. This however, doesn't give us the complete data necessary to reach our conclusion.
2. Secondly, data can be gathered from anonymous qualitative surveys being given to the entire class where questions about their teacher's nature and sensitivity, teacher's level of engagement, interaction, and teaching strategies can be measured. The surveys will also aim to gauge how sensitive, competitive, interactive their peers are within the classroom.

3. The teacher's own engagement with the subject and proficiency in being able to teach the subject can be gauged through personally interviewing them and determining their education background, interaction with their colleagues, years of experience, age, pedagogical philosophies etc.

I think Hypothesis III is a pedagogical issue where we assume that the issue is not about the vast potentiality of mathematics itself but the way in which the education board determines the syllabus of the subject. How the curriculum is decided upon, the way it is presented to the students in the textbook etc all contribute to the problem. To truly study the implications of this, we might need to expand the scope of our experiment to include the study of atleast one other board's curricula if not more.

1. I think the most effective methodological strategy for this would be non-experimentative enquiry based research studying the given boards' pedagogy and syllabus structure objectively and comparing the similarities and differences in their approach.

All 3 of these hypotheses obviously interact, influence, and overlap with each other in varying degrees. The subjects' age, socio-economic background, school environments, sensitivity, their teacher's age, education, socio-economic environment, sensitivity, pedagogical philosophy, the school's environment and philosophy, the classroom environment, the frequency and difficulty of tests, etc all need to be taken into consideration.

The types of research methodology to be employed have already been discussed above. Now the planning of the methodology, and narrowing of the sample being studied has to be discussed:

The subjects being studied must have some uniformity across certain factors:

1. They should all belong to a similar socio-cultural and socio-economic bracket so we can determine whether this factor can be generalized or not in our findings. For eg, a middle class urban locality may be chosen for this purpose
2. They must be of the same age/grade in school. For eg specifically studying 4th graders, or specifically studying 10th graders. We should consider children above the age of 8 for the purpose of this experiment as they will be more articulate while participating.
3. They must belong to the same school and share the same mathematical curricula, like State Boards, or CBSE. (For comparing syllabi effectiveness we might have to further expand this experiment to include several boards of education and compare the effectiveness of their respective curricula).
4. Several sets of several students with the same teachers, across schools need to be observed/interviewed. Perhaps 3-4 schools that follow the same Board and mathematical syllabus can be chosen and within that 8-10 teachers, teaching styles, classroom environments, textbooks can be compared.

It is difficult to cleanly isolate the 3 hypotheses as separately functioning phenomena and anyway, at this point we can only formulate what kind of data should be collected and how it should be

collected in each scenario. Only after data across all these three scenarios is collected can we come to any sort of conclusion about which of the 4 possibilities is in fact true.

4. A list of questions that you wish to raise during class. Each question should contain a short description of the nature of the problem encountered.

Question 1: While writing our response paper, is it better to separate things under subheadings and lists with bolded out clear demarcations or should we write the paper in just a paragraph break form?

5. A detailed description of how you all went about doing your job, especially details of who did what?

As a group, we divided up our work based on the sub headings given in the article How to Read Non-Fiction, by K.P. Mohanan. In the chronological order of this document, Palakshi attempted the sub heading “Reading for Understanding”, Avantik attempted the sub heading “Reading for Deep Comprehension”, and Divya attempted the sub heading of “Reading for Knowledge”. Tanisha and Sanidhya worked on the formulation and write up of the Research Gym Exercise. As a group, we all contributed to the editing, formatting and content of the final document.

Bibliography

Mohanan, K.P. & Tara Mohanan. 2021.Chapter 2 Methodological Strategies *Introduction to Research* 1-14.

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