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The Student's Difficulties in Completing Numeracy Item of Minimum Competency Assessment

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Abstract: Minimum Competency Assessment (MCA) is the latest assessment conducted nationally in Indonesia. MCA measures students' cognitive in literacy and numeracy. This study illustrates the difficulty of students in solving numeracy questions in the minimum competency assessment. This research is included in case study research with a qualitative approach. Data was collected by documenting students' responses to MCA numeracy questions and interviews with math teachers from one school in Mesuji Regency, Indonesia. The analysis technique used is technical triangulation, which includes tests, interviews, and documentation. In addition to students, data were also taken from interviews with math teachers. The results showed that students' difficulty in solving numeracy problems was that students' literacy skills were still lacking, so students had difficulty visualizing and representing mathematically, students did not understand mathematical modelling of the contextual problems given, students' mathematical reasoning was still relatively low, and students were still not used to solving various types and types of counting problems in MCA.

Keywords: MCA, Numeracy, Student Difficulties

Introduction

The National Assessment (AN) is one of the products of the Free Learning Policy, the first episode of the 25 episodes of the Free Learning Policy issued by the Ministry of Education and Culture of the Republic of Indonesia. Assessment is carried out in every school from elementary school to high school. The sample used in this assessment is students in the second year of each level. AN consists of three parts, namely Minimum Compatibility Assessment (MCA), character survey, and learning environment survey.

Minimum Competency Assessment (MCA) is an assessment of the basic competencies needed by all students to be able to develop their capacity and participate positively in society. Minimum Competency Assessment (MCA) is a form of assessment or measurement of fundamental competencies that includes evaluating inputs, processes, and results to improve and map the quality of learning, teaching, and educational services (Ramadhani et al., 2021). MCA has become the main focus in efforts to improve the quality of education. For example, a study conducted in Jember Regency showed that assistance in the development of MCA-based economic/accounting problems for MGMP member high school teachers can increase their knowledge about problem making (Kantun et al., 2021). This illustrates the concrete efforts in implementing MCA as an effective means of evaluation.

In addition, the implementation of MCA also requires careful preparation from various related parties. A study shows that the analysis of student and teacher readiness in national assessments, including MCA, plays an important role in the advancement of education in Indonesia (Ismail & Arifin, 2023). Careful preparation will ensure that the assessment process runs smoothly and provides accurate results.

The importance of Minimum Competency Assessment (MCA) for students and schools has become a major focus in efforts to improve the quality of education in Indonesia. Studies show that MCA is a standard for assessing student competence through mastery of reading literacy and numeracy, which plays a crucial role in evaluating students' abilities (Rokhim et al., 2022). MCA implementation not only affects individual students, but also impacts the entire education system. The research highlights that teachers' understanding of MCA plays an important role in the effectiveness of minimum competency assessment, suggesting that socialization and training for teachers needs to be improved (Asmarni & Zakir, 2023).

The implementation of the Minimum Competency Assessment (MCA) in Indonesia has not yet reached the maximum expected level. Studies show that the evaluation of the implementation of the Computer-Based National Assessment (ANBK) in Madrasah Ibtidaiyah still requires improvement in quality assessment in each education unit and equality programs at the primary and secondary levels (Berlianto & Pembangunan, 2023). The implementation of MCA in SMP Negeri 1 Kebumen Kebumen Regency also highlights the importance of curriculum management and assessment systems in realizing effective schools, indicating that MCA implementation procedures need further attention (Martiyono et al., 2021). In addition, the analysis of students'

numeracy skills in solving geometry problems in MCA shows that there are still students who need special intervention, emphasizing the need for more attention in supporting students' abilities (Wati & Nurcahyo, 2023). In this context, a deep understanding of the concept of MCA, the preparation of valid assessment instruments, and careful preparation are key in improving the effectiveness of MCA implementation in Indonesia. Thus, improvement and improvement measures must continue to be taken to ensure that MCA can function optimally as a tool for evaluating student and school competencies.

Numeracy is a crucial skill that students, parents, and the general public must possess, as agreed by the World Economic Forum in 2015, which established six basic literacy as essential knowledge. A study examining the numeracy knowledge of mathematics students aspiring to become teachers highlights the importance of a deep understanding of the concept of numeracy in an educational context (Ayuningtyas & Sukriyah, 2020). In this context, numeracy includes not only basic mathematical skills but also a broad understanding of the use of numbers, mathematical operations, and problem solving in general. Therefore, a deep understanding of numeracy is key to ensuring that individuals have adequate abilities to participate effectively in daily life and in various fields of knowledge.

Numeracy is a person's ability to reason mathematically and formulate, use, and interpret mathematics to solve problems in a variety of real-world contexts. It includes concepts, procedures, facts, and tools for describing, explaining, and predicting phenomena. It helps individuals to know the role of mathematics in the world and to make sensible judgments and decisions required by constructive, engaged, and reflective 21st century citizens (OECD, 2018)

Numeracy has an important role in student development, especially in relation to early math skills (Kroesbergen et al., 2014). Research shows that numeracy interventions can improve students' objective and subjective numeracy skills, as well as financial and behavioral health decision outcomes (Peters et al., 2017). In addition, numeracy ability also has an impact on student academic achievement, where the school environment and students' perception of the school climate can affect academic achievement through the process of social identity (Reynolds et al., 2017). Improving students' numeracy abilities can also affect national exam results and students' math skills at various levels of education (Martin & Lazendic, 2018). Therefore, understanding the factors that influence student numeracy outcomes is crucial in developing this important competency among students.

Learning difficulties refer to the diverse difficulties experienced by a group of students in acquiring significant literacy and numeracy skills (Adam & Tatnall, 2010). This is important because literacy and numeracy skills are key foundations for educational, professional, and social success (Thomas et al., 2024). Studies show that learning difficulties can affect students' math achievement at different levels of education. Factors such as the school environment, students' perceptions of the school climate, and social identity can also play a role in influencing students' learning difficulties.

Student learning difficulties in doing numeracy problems are challenges that can be faced in the mathematics learning process. Various studies have identified various mistakes that often occur when students solve numeracy problems, such as errors in understanding information, transforming problems, calculations, and doing story problems (Adilla et al., 2020). Factors that cause student learning difficulties in mathematics also include low interest, lack of learning motivation, limited use of learning media, less varied learning strategies, and lack of understanding of mathematical concepts and language (Nailia et al., 2023). Math teachers have an important role in overcoming students' learning difficulties with strategies such as changing students' thinking, providing motivation, and providing independent practice questions (Rubai et al., 2015). Therefore, a deep understanding of the characteristics of student errors and the factors that cause learning difficulties in doing numeracy problems is crucial in designing effective learning approaches to help students overcome these challenges and improve their mathematical understanding optimally.

Lack of research that specifically explores the factors that cause students' difficulties in solving numeracy questions in the minimum competency assessment. Although there are studies that discuss students' learning difficulties in mathematics in general, such as errors in understanding information, problem transformation, calculations, and doing story problems (Nurfadhilah AM. Hindi & Muthahharah, 2021), There has been no research that specifically focuses on students' difficulties in doing numeracy questions in the minimum competency assessment. In addition, in-depth research on effective learning strategies to help students overcome learning difficulties in doing numeracy questions also needs to be explored further (Ziadat & Sakarneh, 2022). Thus, there is a need for more specific and in-depth research to comprehensively understand the factors that influence students' learning difficulties in solving numeracy questions in the minimum competency assessment, as well as the development of appropriate learning strategies to overcome these challenges.

This research was conducted in one of the schools in Mesuji Regency, Lampung Province, Indonesia. Mesuji Regency is one of the regencies located in Lampung Province, Indonesia. The district has an area of about 1,439.70 km² and consists of 9 sub-districts. Mesuji has a population of about 200,000, mostly making a living as farmers. The district is famous for its abundant agricultural potential, especially in producing rice, corn, and oil palm. In addition, Mesuji also has interesting natural beauty, such as protected forests and rivers that flow along its territory. Mesuji also has tourism potential that has not been fully developed but has the potential to become an attractive tourist destination.

It needs qualified human resources to manage all the potential that exists in the Mesuji district. One way that can be done is to encourage the quality of education in the Mesuji district in a better direction. The results of the Minimum Competency Assessment (ACM) show that the quality of human resources, especially at the secondary school level, is still below the provincial average. The following ACM result data is downloaded from the education report card of the National Assessment Center of the Ministry of Education and Culture. In this case MCA does not need to be made up because the purpose is to find out a portrait of students' abilities in school. However, by knowing the difficulties of students, teachers and schools can design learning to improve

the ability to count on target.

Method

This study describes students' difficulties in solving numeracy questions in the minimum competency assessment. This research is included in case study research with a descriptive qualitative approach. The subjects of the study were taken from one of the high schools in Mesuji Regency, Lampung Indonesia. This school with B accreditation status is located in the village. There is already a computer lab, the computer can be operated properly. However, there is no good internet network available. The subject consists of students and teachers. The student is a student who is currently in grade XI with the provision that the student becomes one of the samples from the school for the implementation of MCA in his school. This is done to obtain comprehensive information. The teachers involved are teachers of mathematics subjects and several teachers who are involved in the MCA implementation committee.

Data was collected by documenting student responses to MCA numeracy questions and teacher interviews. Due to the limitations of researchers to access students' MCA answers directly, the numeracy instrument used is structured similarly to the implementation of MCA. The instrument used adopts from the instrument that was developed by Jumini in 2022 The quality of the instrument used has met the requirements of a good instrument, which is valid in content and construct, and is reliably used to measure low, medium and high numeracy capabilities and has good difficulty characteristics (Jumini, 2022).

This research procedure begins with determining the focus of the research. This study will focus on seeing the difficulty of student learning in doing MCA numeracy questions. Next, determine the subject of research. The subjects of this study were students and teachers who had been involved in the implementation of MCA. Then data collection is carried out with test and non-test techniques. The data obtained were described with the Polya approach and validated by triangulation techniques. The final step is the visualization and interpretation of the data. Briefly, the research steps can be seen in Figure 1 below.

4 Data visualization and interpretation
Data description by indicators

3 Collect and process data
Test and non test, discribe with polya model, triangulation technic

2 Determine the setting and research subject
6 Students and 1 mathematics teacher one of school in Mesuji, Indonesia

1 Determine the focus of research
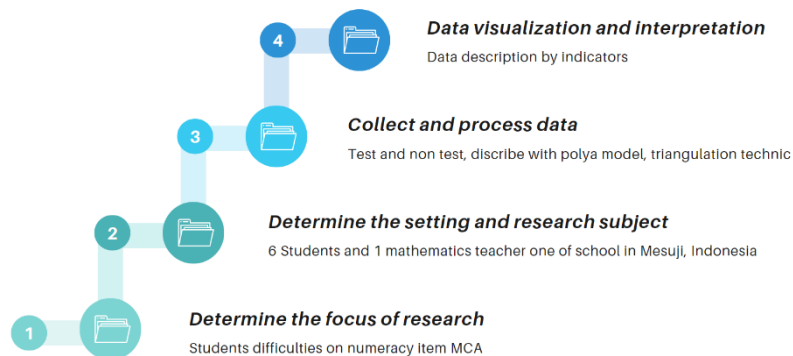Students difficulties on numeracy item MCA

Figure 1. Research Procedure

Polya's problem-solving process involves a series of important steps in solving mathematical problems. Polya's problem-solving model consists of four main stages: (1) understanding the problem, (2) drawing up a problem-solving plan, (3) implementing the problem-solving plan, and (4) examining the answers. The first stage, understanding the problem, involves a deep understanding of the information provided in the question. The second stage, drawing up a problem-solving plan, requires that individuals formulate problem-solving strategies or steps. The third stage, implementing the problem-solving plan, requires the execution of a pre-formulated plan. Finally, the fourth stage, namely checking the answers, is an important step to ensure the correctness and suitability of the answers to the problems given. Although these stages have become the basis for solving mathematical problems, further research is needed to explore the effectiveness and implementation of Polya stages in improving students' comprehensive problem-solving abilities (Anfara et al., 2002; Breitmayer et al., 1993; Carter et al., 2014; Cho & Trent, 2006; Nassaji, 2015).

Descriptive qualitative research often uses triangulation techniques to ensure the validity and reliability of findings. Triangulation can involve combining qualitative and quantitative data in mixed-methods research, such as in-depth interviews and census data, or utilizing a variety of qualitative materials such as narrative texts, focus groups, and selective surveys (Rose, 1993). In this study, polya-solving steps were used to describe the data. The triangulation technique is carried out to ensure the data is valid.

Results
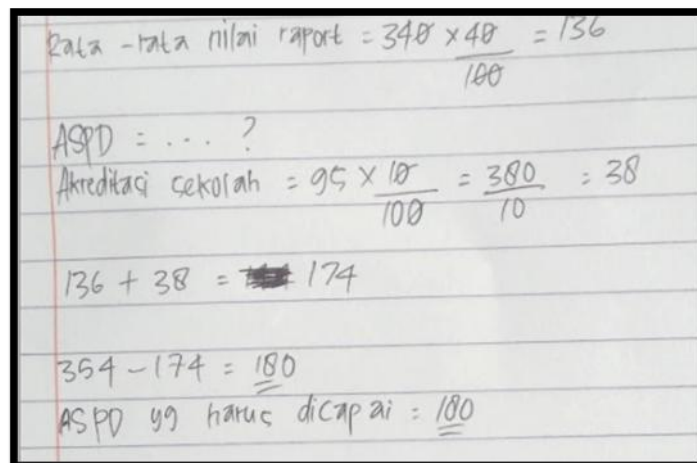
A student's ability to solve numerical problems in the Minimum Competency Assessment (MCA) is often a significant challenge. This difficulty can be caused by several factors, including a student's lack of literacy skills. Many students struggle to understand and apply mathematical concepts appropriately in the context of numerical problems. They have difficulty visualizing and representing mathematically, which hinders their ability to solve problems.

In addition, students also often lack an understanding of the mathematical modelling of a given contextual problem. They have difficulty relating mathematical concepts to situations in problems, making it difficult for them to find appropriate strategies for solving numerical problems. Lack of understanding of mathematical modelling is one of the main factors that hinder students' ability to deal with numerical problems in MCA.

The low mathematical reasoning of students is also one of the causes of difficulty in solving numerical problems. Students often have difficulty formulating problem-solving steps in a logical and structured manner. They tend to face difficulties in analyzing the information given in numerical problems, thus affecting their ability to find the correct answer.

Finally, the lack of familiarity of students in solving various kinds and types of numerical problems in MCA is also one of the main factors of the difficulties faced. Students are often only trained in solving certain types of

problems, so when faced with different numerical problems, they find it difficult and do not have effective strategies for solving problems. The following are presented the results of student work based on Polya's problem-solving steps. The author performs an interpretation of the student's answers. The answers shown are samples only.
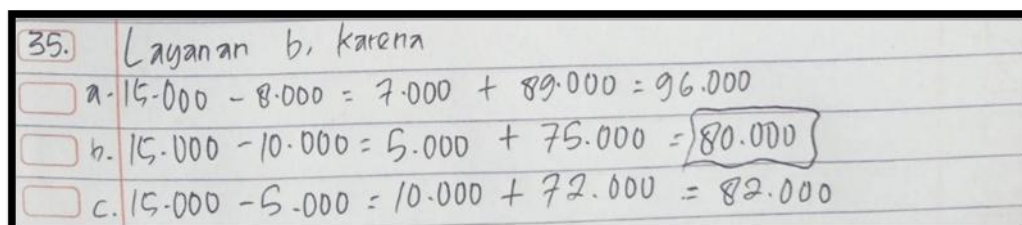
Figure 2. Difficulties of Students Who Have not been able to Understand the Problem Well

From the answers given by the students, it is clear that the student is unable to understand the problems that have been given to him. This lack of understanding results in students making mistakes in the process of creating mathematical modelling that should be used to solve the problem. As a result, the problem is finally resolved without a deep and good understanding of the concepts involved, so the solution given may be inaccurate or inappropriate. This situation emphasizes the importance of understanding fundamental concepts before moving on to the modelling and solving stages of mathematical problems.

Figure 3. Difficulty in Students Plan Problems and İmplementing Problem-Solving Plans

Students who have a good understanding of the given problem are not only able to make effective plans but also can carry out what they have planned well. In addition, their ability to model relevant mathematical concepts becomes stronger, which allows them to construct mathematical modelling precisely and accurately. With a deep understanding, these students can integrate various mathematical concepts in problem-solving, thus achieving the desired results with high efficiency and accuracy.
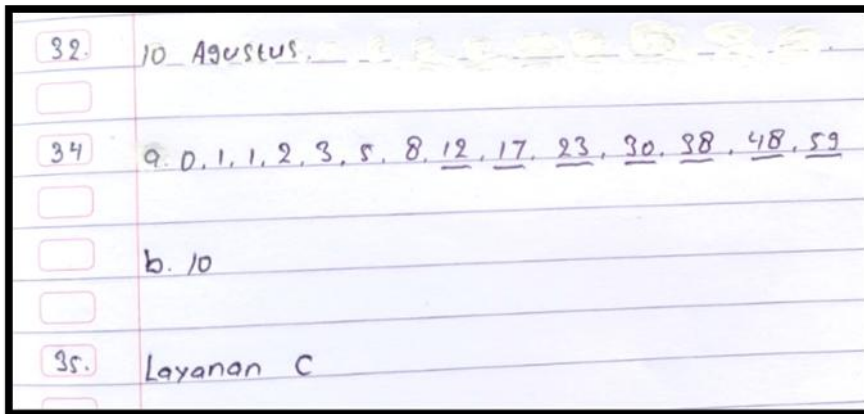
Figure 4. The Difficulty of Students Has not been able to Check the Answers

Even though the student had written the answer on the answer sheet given, it turned out that the resulting answer was wrong. One of the factors that causes this error is that students do not review or review after completing the problem. If students conduct a review, they will probably identify the mistakes made and have a chance to correct them before submitting an answer sheet. The lack of this review step shows how important the review process is in ensuring that the answers given are correct and as requested by the questions.
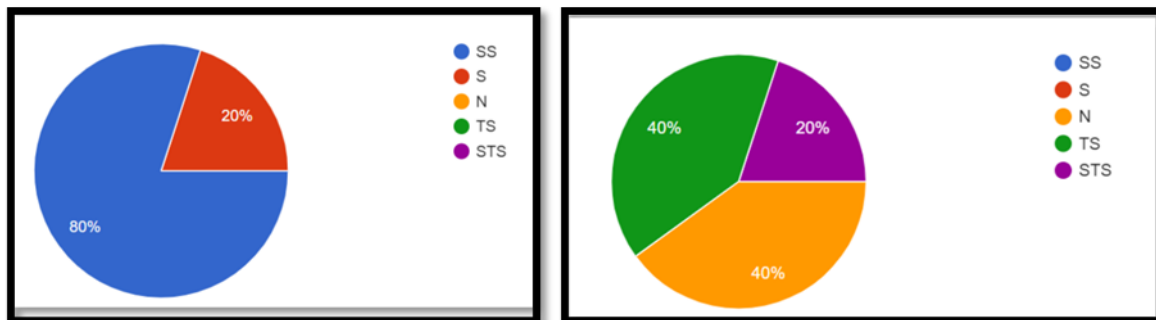
Figure 5. Percentage of Students to MCA Numeracy Question Types

In the first picture, as many as 80% of students feel unfamiliar and unfamiliar with the types of questions given to them. This happens because they have not gained various types of experience needed in the learning process. Lack of exposure to various types of questions and problem-solving methods during teaching and learning activities makes it difficult for students to understand and do problems that are unusual for them. Thus, it is important to provide more variety of questions and rich learning experiences so that students can be better prepared and trained in dealing with different types of questions that may arise.

The next picture, shows that most students feel unhappy and lack enthusiasm when faced with counting problems accompanied by long reading texts. They often find it difficult and burdened with the amount of information that must be deciphered and understood before they can begin to work on calculations. This condition can make the problem-solving process more complicated and time-consuming, thus reducing their

motivation and interest in solving the problem. Therefore, it is important for teachers to consider how to present the questions so that they remain interesting and do not overload students with texts that are too long.

In conclusion, students' difficulty in solving numerical problems in the Minimum Competency Assessment (MCA) can be attributed to several factors. Students' lack of literacy skills hinders them from visualizing and representing mathematically. Lack of understanding of mathematical modeling in contextual problems is also a major obstacle. In addition, students' low mathematical reasoning and lack of experience in solving various kinds and types of numerical problems in MCA also contribute to students' difficulties. Therefore, greater efforts are needed to improve students' mathematical literacy and provide diverse experience in solving numerical problems, so that they can face MCA more prepared and confident.

Discussion

Minimum Competency Assessment (MCA) is a national assessment conducted in Indonesia to evaluate students' cognitive abilities in literacy and numeracy. While assessment aims to measure a student's minimum level of competence, it is critical to identify the specific difficulties students face when solving numeracy questions. The study focuses on exploring the challenges faced by students in this particular field.

To investigate students' difficulties in solving numeracy questions on MCA, a qualitative case study approach was used. Data collection involved documenting student responses to MCA numeracy questions and conducting interviews with math teachers and teachers involved in MCA implementation. This research was conducted in one of the secondary schools in Mesuji district, Lampung, Indonesia.

Analysis of the data revealed some of the difficulties students faced when solving numeracy problems on MCA. First, students exhibit inadequate literacy skills, which hinder their ability to understand and interpret math questions. This lack of literacy skills also affects their ability to effectively communicate their mathematical reasoning. Furthermore, students struggle with visualizing and representing mathematical concepts. These difficulties in spatial reasoning and visualization hinder their ability to solve numeracy problems that require them to manipulate and understand visual representations.

Students often experience various difficulties in doing numeracy problems, including difficulties in understanding and solving math problems. Studies by Fauzi and Arisetyawan (2020) show that students face difficulties in using concepts, principles, and solving verbal problems in answering geometry problems (Fauzi & Arisetyawan, 2020). In addition, research by Ainia and Amir (2021) highlights students' difficulties in solving integer word problems, which shows that students have various ways or methods of solving problem-solving related problems (Ainia & Amir, 2021). These findings suggest that students face diverse challenges in solving math problems, including difficulties in understanding concepts, applying principles, and solving problems verbally, indicating the need for diverse and inclusive learning approaches to help students overcome these

difficulties effectively.

In addition, students lack an understanding of mathematical modelling in contextual questions. They struggle to apply mathematical concepts to real-world situations, demonstrating the need for further instruction and practice in this area. In addition, students show relatively low mathematical reasoning ability. They struggle to apply logical reasoning and critical thinking skills when solving numeracy problems, leading to incorrect or incomplete solutions.

The lack of understanding in mathematical modeling of the contextual questions identified in this study is consistent with the literature. Mathematical modeling involves applying mathematical concepts to real-world situations, and students need explicit instruction and practice to develop these skills. Incorporating real-world context in math problems and providing opportunities for students to engage in modeling activities can enhance their understanding and application of mathematical concepts.

Limited exposure to the different types and formats of numeracy questions identified in this study is consistent with the literature. Research has shown that exposure to different question types and formats can improve students' problem-solving abilities and their ability to transfer their knowledge to different contexts. Therefore, it is important to give students plenty of opportunities to practice and solve different types of counting questions to improve their problem-solving skills. This is in line with previous research that says students often feel unfamiliar with the first type of question on numeracy problems, which can affect their understanding and ability to solve math problems. Unorthodox or unexpected question patterns can create confusion and uncertainty for students, disrupting the effective problem-solving process. This is in line with the concept of triangulation in qualitative research, where the use of various data collection methods such as in-depth interviews, participatory observation, and open text analysis can help gain a comprehensive understanding of students' experiences in dealing with unusual types of questions in numeracy questions (Donkoh, 2023)

The results of interviews with students show below the findings that have been presented by researchers in validated results. Students feel dizzy and headache when they see the form of numeracy questions with long texts. When dealing with contextual sola, they cannot make mathematical models. In contrast to the habits of students in class who are directly taught with mathematical models and directly done with calculations without the need to be analyzed first.

Interviews with mathematics teachers and teachers involved in MCA obtained the following points:
1. Students can't understand the context
2. Teachers assume that students' numeracy skills are only the responsibility of mathematics teachers
3. There is no serious program to improve numeracy skills.
4. Teachers have received numeracy training but have not yet reached the technical level.
5. There needs to be assistance after the education report is published.

6. The ability of students to operate computers is also an obstacle.

7. Facilities and infrastructure need to be improved and integrate learning with IT.

8. Question types need to be varied during learning.

In conclusion, students have difficulty solving counting problems because their literacy skills are still lacking. Therefore, students have difficulty visualizing and representing mathematically, students do not understand the mathematical modelling of the contextual problems given, students' mathematical reasoning is still relatively low, and students are still not used to solving various types of numeracy questions on MCA.

Recommendations

Recommendations for Overcoming Student Difficulties in Solving Numerical Problems in the Minimum Competency Assessment (MCA):

1. Improve students' mathematical literacy: Efforts need to be made to improve students' mathematical literacy skills. This can be done by strengthening the understanding of basic mathematical concepts, involving students in reading and writing activities related to mathematics, and providing opportunities for students to practice mathematical literacy skills in everyday life situations.

2. Focus on mathematical modelling: It is important to pay special attention to mathematical modelling in the context of numerical problems. Students need to be involved in activities that encourage them to relate mathematical concepts to real-world situations. Mathematical modelling exercises can help students better understand and apply mathematical concepts in numerical problem-solving.

3. Improve students' mathematical reasoning: Efforts are required to improve students' mathematical reasoning. Students need to be trained in formulating problem-solving steps in a logical and structured manner. Critical thinking, problem-solving, and data analysis activities can help students develop better mathematical reasoning.

4. Provide a variety of numerical problems: It is important to give students diverse experience in solving a wide variety and types of numerical problems. By providing various questions, students will get used to and be better prepared to face the various types of questions in MCA. In addition, various problems can also help students develop effective strategies for solving numerical problems.

5. Use interactive learning methods: Interactive learning methods, such as group discussions, group work, and math experiments, can help students understand math concepts better. Through interaction with classmates and teachers, students can discuss ideas, share strategies and expand their understanding of mathematics.

6. Provide constructive feedback: It is important to provide constructive feedback to students in solving numerical problems. Specific and helpful feedback can help students understand their mistakes and identify areas for improvement. With constructive feedback, students can learn from their mistakes and develop their ability to solve numerical problems.

7. Provide additional resources: Teachers can provide additional resources, such as reference books, online learning materials, or video tutorials, that students can access as support in learning math concepts and solving numerical problems. These additional resources can help students who need a more independent approach to

learning or need additional understanding.

8. Encourage collaboration between teachers, students and parents: It is important to create collaboration between teachers, students and parents in helping students overcome difficulties in solving numerical problems. Teachers can communicate with parents about the obstacles students face and together find appropriate solutions. Parents can also provide support and motivation to students in developing their math skills.

By implementing these recommendations, it is hoped that students will have a better ability to solve numerical problems on the Minimum Competency Assessment (MCA) and improve their overall mathematical literacy.

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Analysis of Students Algebraic Reasoning Levels in Solving PISA Model Problems in View of Adversity Quotient

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Abstract: This research aims to describe students' level of algebraic reasoning based on the adversity quotient types of climber, camper, and quitter in solving PISA model mathematics problems. This research is descriptive research with a qualitative approach. The research began by administering a questionnaire to determine the student's adversity quotient type. After obtaining research subjects consisting of 3 climber-type students, 2 camper-type students, and 3 quitter-type students, the research continued with giving a PISA model problem-solving test (TPM) with think-aloud commands, and interviews. The data obtained was transcribed and validated using triangulation methods and then analyzed based on algebraic reasoning level indicators consisting of levels 0-3. The research results show that students with different adversity quotients achieve different levels in solving PISA model problems. Climber-type students meet levels 1 and 2, camper-type students meet level 1, and quitter-type students meet level 0.

Keywords: Level of Algebraic Reasoning, PISA Model Questions, Adversity Quotient

Introduction

Mathematics has a crucial role in developing a person's thinking and reasoning skills, so it becomes an integral part of the curriculum at all levels of education, from elementary school to college. Mathematics consists of several branches, one of the branches that must be mastered by students is Algebra. Algebra is a branch of mathematics concerned with the way we express generalizations about numbers, quantities, relations, and functions (Watson, 2010). This is supported by the statement that Algebra is a collection of concepts, ways of thinking, and skills that allow students to generalize, model, and analyze mathematical situations (NCTM, 2000). Thus, it is important to master algebra as a basis for generalizing related to mathematics.

The topic of algebra is related to abstract structures and the use of the principles of abstract structures in solving mathematical problems (NCTM, 2000). Algebra is said to be abstract about symbols, hence learning algebra requires the ability to understand symbols, their operations and rules (Andriani, 2015). The ability to understand symbols is explored in algebraic reasoning which contains the skills to understand patterns and make generalizations (Andriani, 2015; Ozturk, 2023). Algebraic reasoning is the generalization of mathematical ideas from a particular thing through argumentation and expressed formally according to the age of the student (Gardner & James, 1995). Algebraic reasoning is a type of reasoning used in solving algebraic problems (Blanton & Kaput, 2005). Thus, in algebraic reasoning, the ability to understand symbols plays an important role in recognizing mathematical patterns and making generalizations that enable students to apply their algebraic knowledge and skills effectively in a variety of mathematical contexts.

Algebraic reasoning has an important role to play in encouraging students of all ages to make guesses, devise rules, and generalize their learning (Ontario, 2012). In the process of drafting this rule, it should be noted that many students experience difficulties when they are faced with problems that have a different form from the one taught by the teacher (Bocro & Dapunto, 2007; Saglam & Akman, 2023). Most teachers are unaware of how students learn and master complex concepts, rules, procedures, or processes in mathematics (Thuneberg et al., 2018). Therefore, it is important to develop algebraic reasoning that can see structures in a variety of contexts, both in solving problems involving numbers or situations being modeled, as well as in the study of more general structures (Andriani, 2015). In algebraic reasoning, individuals can recognize patterns, relationships, and prevailing general principles, which helps them understand and solve math problems better.

The level of algebraic reasoning can be known through the process of solving problems. This statement is supported by NCTM which reveals that reasoning skills are needed when students are required to solve problems and draw conclusions in everyday life (NCTM, 2000). Problems occur when someone has a goal but does not know how to achieve it, while problem-solving is a process of student effort by using all the knowledge, skills, and understanding he has to find solutions to problems given or faced (OECD, 2013). Understanding different problems leads to different problem-solving. To measure and understand students' level of algebraic reasoning, it is important to provide them with problems that are often encountered in everyday life and have direct relevance to their lives. One type of question that meets this criterion is the PISA model question.

PISA itself focuses on students' ability to use their knowledge and skills in dealing with real-life challenges (OECD, 2013). By providing students with PISA model problems, it allows students to apply mathematical concepts in the context of everyday life so that they can see the relevance and usefulness of mathematics in real life. In addition, problem solving through PISA model questions can also help develop critical, analytical, and creative thinking skills, as well as improve students' ability to develop effective problem-solving strategies. Thus, the use of PISA model problems in algebraic reasoning research can provide a comprehensive picture of

student's ability to solve mathematical problems contextually and see the extent to which students can apply algebraic reasoning in real-life situations.

The application of algebraic reasoning in solving problems needs to consider students' attitudes in facing challenges and difficulties that can affect students' motivation, confidence, and attitude toward problems. The ability of students to deal with problems and difficulties is commonly called the Adversity Quotient (Nada et al., 2020). The Adversity Quotient (AQ) is the intelligence that a person has when faced with a problem and is required to solve it (Stoltz, 2000). AQ is divided into three types, namely (1) climbers, a group of people who persistently try to reach the peak of success, (2) campers, a group of people who still have the desire to go through the challenges that exist, but do not reach the peak of success and are quickly satisfied with what is achieved, and (3) quitters, is a group of people who prefer to avoid and reject existing opportunities, easily discouraged, easily give up, and not eager to reach the peak of success (Stoltz, 2000).

Several studies discuss algebraic reasoning (Authary & Nazariah, 2019; Nuraini et al., 2016; Puspitasari, 2019), but there have been no studies that reveal the level of algebraic reasoning in solving PISA model problems in terms of adversity quotient. This research can provide a more comprehensive understanding of algebraic reasoning as well as insight into how resilient students are to difficulties and challenges in mathematics learning, especially in the context of algebraic reasoning. So that researchers are interested in examining "the level of algebraic reasoning of grade IX students in solving PISA model problems in terms of adversity quotient".

Method

This research is descriptive research with a qualitative approach that aims to describe the level of algebraic reasoning of students based on the adversity quotient type of climber, camper, and quitter in solving PISA model problems. The research instrument consists of adversity quotient questionnaires, PISA model problem-solving tests (TPM) with think-aloud commands, and interview guidelines. The instrument has been validated by 3 experts in the field of Mathematics and Psychology Education. The data obtained in the transcript is then analyzed based on the adaptation of algebraic reasoning level indicators (Ake et al., 2013) consisting of levels 0-3 including using known information, using patterns, appearing symbols, to making generalizations.

Table 1. Algebraic Reasoning Level Indicator

Algebraic Reasoning Indicator Code	Reasoning Levels	Algebraic Reasoning Indicators
L1	Level 0	Students can identify concrete examples of a pattern or situation but are unable to generalize. Students use a trial-and-error approach in solving problems without being able to formally explain or generalize

concepts.

L2	Level 1	Students can identify more abstract patterns or situations and can make simple generalizations. They can identify relationships between variables and make generalizations based on the patterns they observe.
L3	Level 2	Students at this level can develop more complex generalizations and construct arguments to support their generalizations. They are able to formally explain the mathematical relationships between variables and use the language of algebra to interpret the patterns they observe.
L4	Level 3	Students are capable of very complex generalizations and can extend their generalizations to a variety of mathematical contexts. They are able to identify and apply abstract structural principles in solving more complex mathematical problems.

The subjects of the study were 8 students of grade IX MTsN 2 Malang City with climber, camper, and quitter categories. Determination of subjects is carried out by purpose sampling techniques, namely determining the class that will be the subject of research based on recommendations from teachers to obtain appropriate data. The first step of the researcher was to give an adversity quotient (AQ) questionnaire to 80 students in grades 9D and 9F MTsN 2 Malang City who had been recommended by the teacher through a google form, then the results of the questionnaire were analyzed and 3 climber type students, 2 camper type students, and 3 quitter type students were selected to be the subject of research. The determination of AQ categories based on ARP scores (Stoltz, 2000) is presented in the following table.

Table 2. AQ Category Score

Number	Score	Student Category
1.	166-200	Climber
2.	95-134	Camper
3.	0-59	Quitter

Selected students are asked to solve PISA model problems contained in individual problem-solving test sheets, write down the steps clearly accompanied by *think aloud* during the problem solving process recorded using a voice recording device.

Figure 1. Problem-Solving Test Questions

After students take the test, it is followed by an interview. The interview included structured and open interviews regarding students' algebraic reasoning in solving PISA model problems. Structured interviews by the instruments that have been prepared, open interviews are interviews that can develop according to field conditions.
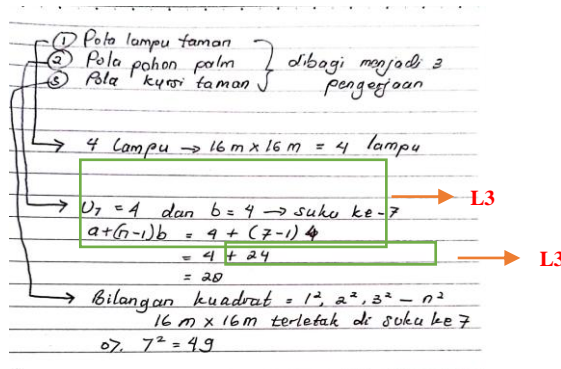
Checking the validity of data in this study uses triangulation methods by comparing data sources in the form of problem-solving test results, think-aloud results, and student interview results. It is said to be valid if the data source has many similarities. Valid data were analyzed to describe students' levels and characteristics of algebraic reasoning. The data analysis stage is carried out by examining all data which includes problem-solving test results, think-aloud results, and interview results. The data was analyzed following the steps taken by Miles & Huberman consisting of data reduction, data presentation, conclusion drawing, and data verification.

Results

This section presents the results and discusses the answers of each subject on the written test, think-aloud, and interview. Each subject was assigned the codes S1, S2, and S3 for three climber-type subjects, S4 and S5 for camper-type subjects, and S6, S7, and S8 for quitter-type subjects. The following is exposure to research results from research subjects.

Description of S1 Research Results

S1 can identify known information and use known information to resolve problems. This is shown in the following figure.

Figure 2. S1 Answer Sheet

Based on the answer sheet in figure 2, S1 finds many palm trees using the arithmetic sequence formula, namely. In addition, S1 writes the symbol n$a + (n-1)b^2$ to perform a square number example. The use of arithmetic sequence formulas and the example of quadratic numbers on this answer sheet shows that S1 is able to formally explain mathematical relationships between variables and use algebraic language to interpret the patterns they observe, this is reinforced by the following think-aloud results.

Think Aloud S1 Results

> After looking for many lights, then looking for palm tree patterns, it can be seen that many trees form arithmetic rows with U1 = 4 and b = 4 (pause) then for a garden measuring 16 m x 16 m is the one, two, three, four, five, six, seven. So that the palm tree in the garden measuring 16 m x 16 m is a + (n-1)b, just enter into the formula obtained 4 + (7-1)4 = 4 + 24 = 28.

S1 strengthens the use of arithmetic sequence formulas by explaining the purpose of writing the symbols written on the answer sheet, this can be observed from the results of the following interview.

Q: "Try to explain the meaning of what you wrote, such as a, U1 and others."

S: "U1 is the first series of the problem, the above problem has several garden sizes, namely 4, 6, 8. Why is it called U1, called U1 because from these measures it can be seen from 4 to 6 has a difference of 2, likewise from 6 to 8 has a difference of 2, a is the initial term known from the above problem, meaning a is the earliest size of the garden on the left, while b is the difference or difference known from the question above, means B is known to have a difference of 2. Then n is the number of tribes. From the above questions asked is a size of 16 m x 16 m, then from the first series to 16 there are seven steps."

Description of S2 Research Results

S2 knows the information referred to by the question and states that in the question there is a square-shaped garden, this is shown by the following think aloud results.

> I looked at the garden on this matter in the shape of a square, (paused) according to the garden size 4 m x 4 m, 6 m x 6 m, and also 8 m x 8 m, so the garden size 16 m x 16 m is square.
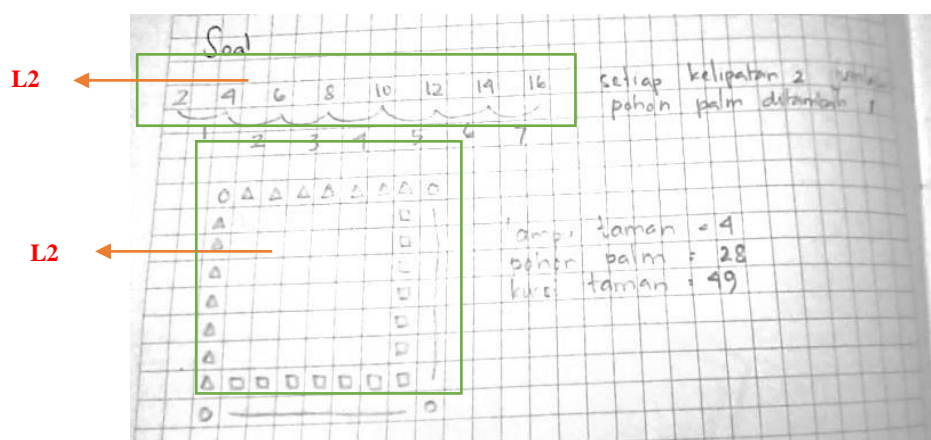
Figure 3. S2 Answer Sheet

Figure 3 shows that S2 performs a problem-solving process based on known information by drawing a pattern of multiples of two using symbols to determine the sequence of garden patterns measuring 16 m x 16 m. This is reinforced by the results of the following interview.

Q: "What do you mean by this pattern?"
S: "The meaning of the pattern, multiples of two ranging from 4 plus 2 to 16, after arriving at 16 plus one tree."
S: "Garden lights are circles, trees are triangular, chairs are squares."

Description of S3 Research Results

S3 writes known information on the answer sheet using symbols consisting of a square symbol to represent a chair, a triangle symbol to represent a tree, and a circle symbol to represent a lamp. This is according to figure 4 below.

The use of symbols in writing information known to S3 on the answer sheet is reinforced by the results of the following interview.

Q: "Do you use symbols in solving problems?"

S: "Yes sis, symbol of lights, trees, and chairs."
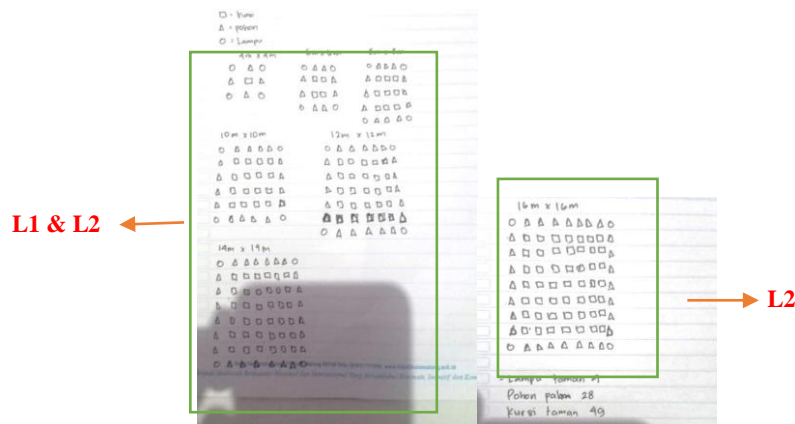
Figure 4. S3 Answer Sheet

The second step taken by S3 is to use known information to resolve the issue. S3 performs the problem solving process based on the garden sequence pattern, Here are the results of *think aloud* that supports S3 to solve the problem based on the garden sequence pattern.

Think Aloud S3 Results

The garden measuring 4 m x 4 m to the garden measuring 6 m x 6 m applies multiples of 2, judging from the brown picture in the garden measuring 4 m x 4 m the number is 1, then in the garden measuring 6 m x 6 m the number is to the right two to the left two so the sum is 4. Then in the garden the size of 8 m x 8 m is also the same, the brown picture applies multiples of 3 to the right and 3 to the left to 6. So we continue to draw the next park measuring 8 m x 8 m, 10 m x 10 m, 12 m x 12 m, 14 m x 14 m, and 16 m x 16 m.

Description of S4 Research Results

S4 solves the problem using a sequence of patterns, it can be seen when looking for many palm trees the subject writes the numbers 4, 8, 12, 16, 20, 24, and 28 where this number shows a sequence pattern of multiples of 4. In addition, in searching for many garden chairs, subjects wrote down the numbers 4, 9, 16, 25, 36, and 49 where this pattern is a sequence pattern of squared numbers.

S4 revealed that there is a pattern of multiples of odd numbers in the garden chair pattern, this is shown by the results of the following interview.

Q: "What do you understand from the problem?"

S: "Multiples of the same number, the number of garden chairs is 9 plus 5, then in add 7, and so on."
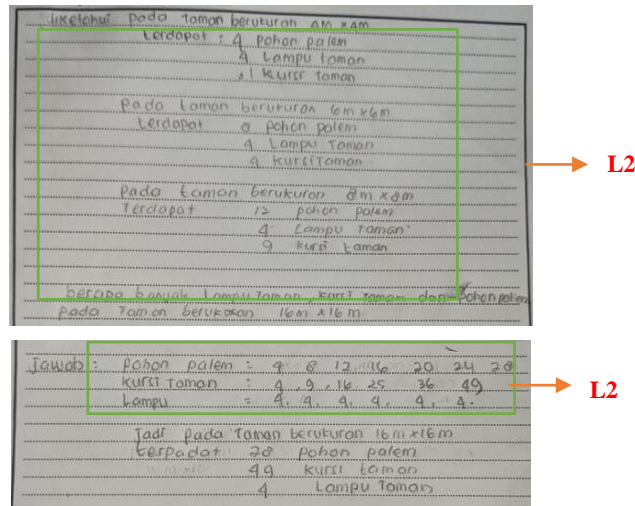
Figure 5. S4 Answer Sheet

The next step taken by S4 is to count many palm trees, garden chairs, and garden lights, each of which obtained 28 palm trees, 49 chairs, and 4 garden lights. Here's the S4 think aloud result showing lots of lights, trees, and garden chairs.

From calculations I get the results of 28 palm trees, 49 garden chairs, and at a garden size of 16 m x 16 m many lamps are 4 lamps.

Description of S5 Research Results

S5 writes down the known information on the subject's answer sheet in the form of writing symbols to represent lights, chairs, and palm trees, where the square symbol represents the chair, the circle symbol represents the lamp, and the triangle symbol represents the tree according to figure 6 below.

The use of symbols to represent garden lights, palm trees, and garden chairs in problem solving is reinforced by the results of the following interview.

Q: "Do you use symbols when doing problems?"
S: "Yes, the symbol is a circle, square, equal to a triangle."

The next step taken by S5 is to calculate the number of triangles, squares, and circles in a garden measuring 16 m x 16 m according to the question request. Based on calculations made by S5, 4 garden lights, 28 palm trees were obtained from the sum of trees around the park, and 49 garden chairs.
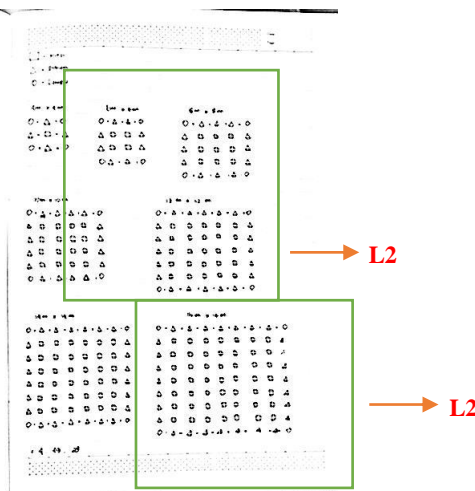
Figure 6. S5 Answer Sheet

Description of S6 Research Results

S6 does not write down the known information on the answer sheet according to Figure 7 below but goes directly to the problem-solving process of writing the perimeter of the square to find lots of garden lights, palm trees, and garden chairs.
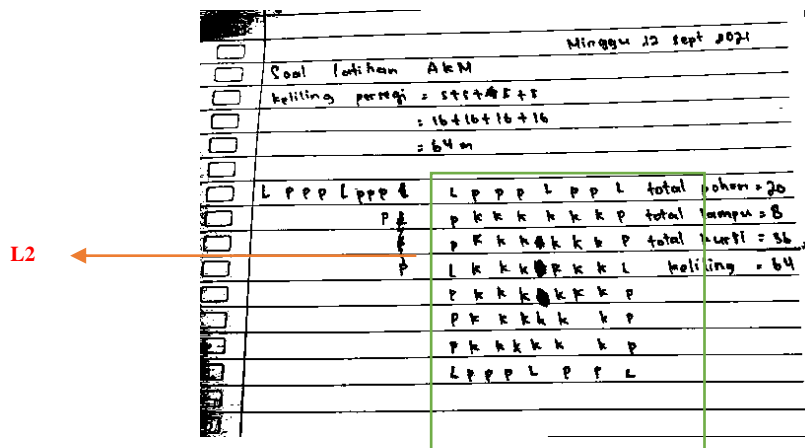
Figure 7. S6 Answer Sheet

Figure 7 shows that S6 lacks understanding of the command to search for lots of garden lights, palm trees, and garden chairs, as supported by the following interview.

> Q: "What do you know from the question?"
>
> S: "about lights, trees, and chairs."
>
> Q: "How to solve it?"
>
> S: " em.. (space) the number."

S6 does not understand the commands of the problem. In S6's understanding, the garden will be dark if the garden lights are only in the corner, so the S6 adds two lights to the garden where this does not fit the existing

pattern. Here are the results of think-aloud S6.

Think Aloud S6 Results

> There are 8 sides, meaning (silent) the arrangement must be 4, then if the size is 16 the arrangement must be 8. There are 8 trees, if there are only 4 lights it will be dark seats, so 2 lights are added on each side so that it does not get dark

S6's lack of understanding of the question commands can be seen from the results of the following interview.

Q: "Is there a pattern you use to solve the problem?"

S: "No sis."

Seeing S6's lack of understanding in troubleshooting results in S6 not being able to troubleshoot correctly.

Description of S7 Research Results

S7 looks for percentages in the troubleshooting process, this does not match the question command and indicates that S7 does not understand the known information and how it is solved. Here's the S7 answer sheet.
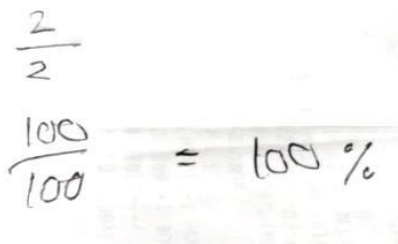
Figure 8. S7 Answer Sheet

S7 knows the command from the problem to find many lights, chairs, and palm trees, but S7 does not know how to solve the problem contained in the problem. This is shown by the results of the following interview.

Q: "After reading the questions, what information do you know from the questions?"

S: "There are lights, chairs, and some trees."

Q: "After that, what did you do to solve the problem?"

S: "I was confused at that time, and did not know what formula to use, I did it freely."

Description of S8 Research Results

S8 performs troubleshooting by using symbols and continuing patterns from the problem, the triangle symbol used for trees, the circle symbol for chairs, and the circle triangle symbol for lights. This is reinforced by the

following *S8 think-aloud* results.

Think Aloud S8 Results

I drew a picture first, in the size of a garden of 10 there are four trees down and four trees to the side, the seats follow the number of trees. In the garden size 12, there are 5 trees down and to the side, the picture of a chair following the tree. In garden size 14 there are 6 trees down and to the side, the image of a chair follows the tree. But for a while, I replaced the tree triangle, just this lampshade, the chair is a circle.
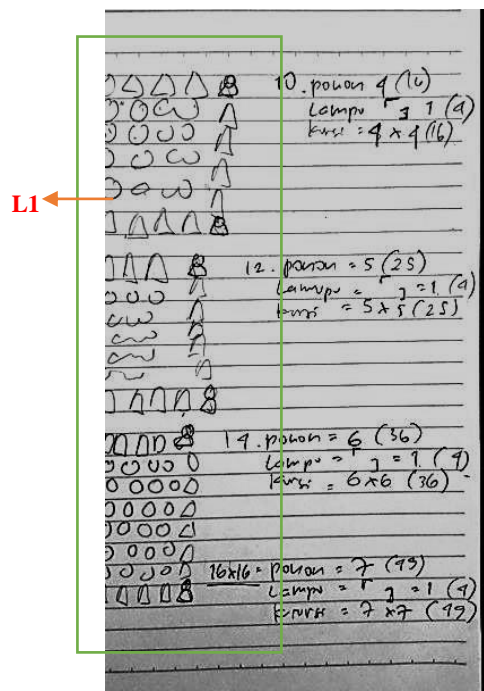
Figure 9. S8 Answer Sheet

As seen in Figure 9, S8 continues the pattern in the problem by drawing a garden using a triangle symbol to represent a tree, a triangle, and circle symbol to represent lights, and a circle symbol to represent a chair. The use of symbols for problem-solving is reinforced by the results of the following interview.

Q: "After knowing the information, what did you do to solve the problem?"

S: "I draw every number."

Q: "What kind of picture?"

S: "Picture like on my answer sheet."

After creating the symbol and continuing the problem pattern, the next step that S4 does is to count the number of lights, chairs, and trees based on the sequence of patterns according to the image that has been made. But the workaround done by S8 is not quite right.

Discussion

The following results summarize the levels and characteristics of student algebraic reasoning in solving the PISA model problems described above.

Table 3. Levels and Characteristics of Subject Algebraic Reasoning

Subject	Algebraic Reasoning Levels	Characteristics of Algebraic Reasoning
Climber	Level 1	Subjects are able to identify patterns, use symbols in solving problems, and make generalizations based on patterns that have been observed.
	Level 2	Subjects are able to identify patterns, use symbols to solve problems, and use algebraic language to interpret patterns that have been observed.
Camper	Level 1	Subjects are able to identify patterns, use symbols in solving problems, and make generalizations based on patterns that have been observed.
Quitted	Level 0	Understanding of the known information is still lacking, so problem solving is less precise.

Algebraic Reasoning Levels of Climber, Camper, and Quitter Type Students in Solving PISA Model Problems

The results showed that each subject with a different adversity quotient reached different levels in solving the PISA model problem. Three subjects with climber-type adversity quotients differed levels in solving PISA model problems, two subjects reached level 1, and one subject reached level 2. Two camper-type subjects in solving PISA model problems achieved level 1 algebraic reasoning. While the three quitter-type subjects still reached level 0.

Algebraic Reasoning Characteristics of Climber, Camper, and Quitter Type Students in Solving PISA Model Problems

The characteristics of algebraic reasoning of climber, camper, and quitter-type students in solving PISA model problems differ according to the level of algebraic reasoning achieved by each student. The characteristics of students' algebraic reasoning are as follows.

Algebraic Reasoning Characteristics of Climber-Type Students in Solving PISA Model Problems

The characteristics of climber-type subjects who meet level 1 are that the subject is able to identify patterns, use symbols in solving problems, and make generalizations based on observed patterns. This is in accordance with research that states that climber-type students (Abdiyani et al., 2019) can write down detailed problem-solving strategies using open sentences. So that students with climber type can meet level 1.

At level 2, the characteristic of climber-type subjects is that the subject uses algebraic language to interpret observed patterns, this is apparent when the subject uses arithmetic sequence formulas to solve problems. This is in accordance with research that states that (Rahayu & Alyani, 2020) climber-type students can understand the concept shown by students can bring up a general form in solving problems. So that students with climber type can meet level 2.

Characteristics of Camper Type Student Algebraic Reasoning in Solving PISA Model Problems

At level 1, the subject of type Camper has the characteristic of spawning symbols and using symbols to solve problems. This is by research that states that students type Camper In making problem planning, you can explain problem planning that will be used as a guideline in solving problems by writing problem-solving strategies using open sentences. So that students with type Camper can meet level 1.

Characteristics of Algebraic Reasoning of Quitter-Type Students in Solving PISA Model Problems

The characteristic of quitter-type subjects is that the subject makes errors in solving problems without being able to formally explain or generalize concepts. This is to research which states that (Saniyyah & Vienna, 2020) quitter-type students make problem-solving guesses so students with quitter type are classified as meeting level 0.

Based on the exposure to the data above, information was obtained that in solving the PISA model problem there was a similarity in the level of algebraic reasoning of climber and camper type subjects, while quitter type subjects met a lower level of algebraic reasoning than camper type subjects.

Conclusion

Students with different adversity quotients reach different levels of problem-solving PISA models. Students with climber-type meet level 1 and 2, camper-type students meet level 1, and quitter-type students meet level 0. The characteristics of algebraic reasoning of climber-type students who can meet level 2 are The subject uses symbols in solving problems, as well as using algebraic language to interpret patterns that have been observed. Subjects who can meet level 1 have the characteristics of Subjects who can identify patterns, use symbols in solving problems, and make generalizations based on observed patterns. The characteristics of camper-type subjects are that they bring up symbols and use symbols to solve problems. The characteristic of quitter-type

students' algebraic reasoning is that the subject makes errors in solving problems without being able to formally explain or generalize concepts.

Recommendations

Based on the results of the above research, the following suggestions were put forward: a) For teachers, they should choose interesting learning methods and models and routinely provide various practice questions as an effort to improve students' algebraic reasoning level. b) Further researchers can conduct research with the same or almost the same subject characteristics to see the reliability of the research.

Acknowledgements

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Why Does Deep Ecology Concept Support Education for Sustainability? A Case Study in Islamic Boarding School

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Abstract: Over the last few years, the topic of environmental change has emerged as a major global concern. This occurs as humans become more aware of the effects of environmental change, such as flash floods, excessive heat and drought, forest fires, and rising sea levels. These environmental disasters are substantially the outgrowth of mortal exertion on the terrain over time. Deep ecology is a philosophical concept and environmental movement that focuses on the relationship between humans and nature. Deep ecology adopts an ecocentric (ecosystem-centered) rather than an anthropocentric perspective. The purpose of this study is to examine the importance of incorporating in-depth ecological principles into biology classes to improve environmental attitudes and behavior in sustainable education. For this purpose, researchers conducted survey research with a phenomenological design. A series of questions in a questionnaire to measure eco-centric, anthropocentric, environmental apathy, and sustainability attitudes were used in this research with 240 Islamic boarding school student respondents. The results of this research: 1) students are more likely to have an attitude of using the environment for the benefit or welfare of humans (Anthropocentric), 2) caring attitudes relating to students' concerns about sustainability are classed as low, and 3) age and parental education are two student characteristics that have a significant impact on their opinions. Through the results of this research, we highly recommend a Sustainable Education curriculum that supports the formation of students' more ecological attitudes.

Keywords: Anthropocentric, Biology Learning, Eco-Centric, Esd

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Introduction

Deep ecology is a philosophical view regarding the relationship between humans and the natural environment developed by the Norwegian ecological philosopher, Arne Naess, in 1973 (Naess, 2019; Petrus & Louw, 2015). Deep ecology rejects the anthropocentric paradigm which sees humans as the center of everything and places human values above natural values. Deep ecology includes eight basic positions introduced by Arne Naess as its philosophical foundation. One of the keys to this view is the understanding that nature has intrinsic value that is independent of human existence. Deep ecology emphasizes that every living entity has its right to existence, not only as a resource for humans. Deep ecology positions humans as an integral part of a larger ecosystem, and this view raises awareness of the interdependence and connections between all forms of life in nature. This concept rejects the sharp separation between humans and nature and proposes that humans view themselves as part of a larger circle of life, with deep interdependence with nature (Devall, 1980; Marais-Potgieter & Thatcher, 2023; McLaughlin, 1995; Pepper, 1995; Rosenhek, 2004; Sessions, 1987).

The concept of deep ecology has a strong connection with the phenomenon of natural destruction that has occurred in this century (Bradford, 1989; David et al., 2021; Hameed et al., 2019). In this context, natural damage such as deforestation, climate change and loss of biodiversity are considered to be the result of an anthropocentric view that dominates human thought patterns and actions towards the environment. Focusing on human interests without considering the intrinsic value of nature has encouraged excessive exploitation of natural resources. A view that sees nature only as an economic resource without considering its intrinsic value. Deep ecology invites humans to see themselves as an integral part of the global ecosystem, not as holders of exclusive rights (Breivik, 2019; Stevenson, 2021). Deep Ecology creates the foundation for social and cultural transformation (Cook, J, 2018). Contributions that can help address the root causes of natural destruction, provide direction for changes in thinking patterns and more sustainable actions, and support efforts towards broader environmental sustainability.

The deep ecology perspective can aid in the resolution of the global environmental crisis by offering a foundation for thought that can bring solutions to difficult environmental challenges (Bradford, 1989; Petrus & Louw, 2015). Understanding and using deep ecology concepts allows us to build more effective plans and activities for environmental protection. As a result, a deep ecology perspective may hold the key to guiding education toward long-term good improvements in the connection between humans and the environment (Akamani, 2020). The potential to modify human perceptions about the environment is central to the notion of deep ecology in the context of education for wishes. Deep ecology promotes an understanding of nature's intrinsic worth and the necessity to live in harmony with ecosystems (Aktürk Çetin, 2022; Kowalewski, 2002; Petrus & Louw, 2015). This understanding may help to shape a more sustainable and ecologically responsible

mentality, as well as serve as the foundation for sustainability-focused education. Aside from that, deep ecology helps students develop a participative and collaborative attitude toward addressing poverty concerns by immersing them in a deep understanding of the link between humans and the environment. Future leaders who care about and are devoted to environmental conservation may be created via sustainability education (Marouli, 2021).

The deep ecology approach can assist in overcoming the global environmental crisis by offering a justification for solving complicated environmental challenges (Biermann, 2021; Brand et al., 2020). Understanding the concepts of deep ecology allows us to build more effective plans and activities for ensuring the earth's sustainability. As a result, a deep ecology approach may hold the key to steering education toward long-term improvements in human-environment interaction. Deep ecology can make a substantial contribution to the creation of sustainable educational curricula (Kowalewski, 2002; David Molina-Motos, 2019; Sinakou et al., 2019; Smith, 2019). A curriculum that includes the fundamental ideas of deep ecology into the curriculum will be more comprehensive, including spiritual and moral values relating to the environment. This contributes to the development of a more conscious generation of pupils.

This article discusses the results of analysis of eco-centric or deep ecology scale measurements for boarding high school students based on religious education. Apart from the ecocentric scale (deep ecology), a scale for measuring attitudes towards sustainable education is also used. The results of the ecocentric scale measurements are then linked to the implementation of education for sustainability. The assessment scale used adapts the Ecocentric and Anthropocentric Attitudes Toward the Sustainable Development (EAATSD) Scale (H Kopnina, 2012) (Table 2).

Deep Ecology Arne Naess

Deep ecology teaches the need for a deep awareness of oneself and all other living things. This concept proposes an awareness and basic principle that all creatures in nature are connected and interconnected to form a group of equal beings, carrying a high spiritual connotation, although its religiosity is not explicitly expressed in the character of this philosophy. The term deep ecology comes from the work of Arne Naess (Glasser, 1996; Naess, 2019) who uses the metaphor of a deep ecology tree to express a tree with long and strong roots and different branches consisting of ideas from religions, namely Hinduism, Confucius and Buddha on the one hand, and Aristotle, Heidegger, and Spinoza on the other (Ims, 2015). The connectivity between spirituality and nature is determined by the philosophical concepts of deep ecology. Several deep ecology concepts are embraced by Eastern religions (Ekoloji & Ahimsa, 2021; Javanaud, 2020). Deep ecology is the opposite of shallow ecology (shallow ecology) which focuses on treating symptoms and finding technology to overcome environmental problems. In contrast, "deep in deep ecology" radically undermines the anthropocentric worldview and requires a non-reductionist approach that gets to the root of the problem. The realization of these roots, according to philosophy (Naess, 2019) is possible through understanding the self. Furthermore, Naess stated that we must see

the vital needs of ecosystems and other species as our own needs so that there will be no conflict of interest. The principles of deep ecology precisely provide an example of a variety of eco-spiritualities looking at nature and all existing creatures.

The following is a set of principles or key terms and phrases, agreed by George Sessions and Arne Naess as the basis of deep ecology (Naess, 2019).

1. The welfare and progress of humanity and non-human life (other living creatures) on Earth have their value (intrinsic value, inherent value). This intrinsic value does not depend on the use of other living creatures for human purposes or interests.

2. The richness and diversity of life forms contribute to the relationship between these values and the values within living creatures.

3. Humans have no right to reduce this richness of diversity and variety except to meet vital needs.

4. The development of human life and culture occurred simultaneously with a substantial decline in the human population. The development of other living creatures requires a decrease in that population.

5. Current human involvement with nature is too excessive, and the situation is progressively deteriorating.

6. Policies must be changed. These policies affect basic economics, technology, and ideology. Policy changes will change the current situation.

7. Ideological change mainly occurs in the appreciation of the quality of life (living in a situation that is inherited inherent values) rather than embracing values that further promote a higher standard of human life. This will form a deep awareness of consciousness and there will be a difference between the big ones.

8. Those who adhere to the above points have a direct or indirect obligation to try to implement the necessary changes. This eighth principle is the basis for the process of following/developing/creating other similar principles.

Deep Ecology Criticism

Each person creates their unique philosophy throughout their life based on how they acquire their views and the belief system to which they adhere. Although frequently unconscious, these beliefs continually affect our thoughts, decisions, and emotions, ultimately determining our lives. Deep Ecology, as a belief system, is a new way of understanding our relationship with the environment and with one another, and it influences how we act. Deep Ecology, on the other hand, does not just seek intrinsic worth or build universal moral principles. More than that, the purpose is to alter and re-direct human awareness, rather than simply discovering moral ideals or norms. Significant changes must occur through paradigm shifts and human consciousness reorientation if we are to develop a new world and type of society (Aktürk Çetin, 2022; Anderson, 2020; Petrus & Louw, 2015).

Criticism of the philosophy of deep ecology comes from several scientists who state that the biocentric concept is seen as hating humans, deep ecology reduces humans from complex social creatures to simple creatures. Other scholars consider biocentric egalitarianism hypocritical. Humans can't be treated as equals to nature, and

humans should not allow nature to unleash its full potential. They think that the eco-sophical position is not egalitarian and not completely biocentric because a completely egalitarian biocentric ethic will not limit human behavior compared to the behavior of animals or other creatures. This is the opinion that humans will only care about the environment if they see the benefits for humans (Petrus & Louw, 2015).

Humanity and the environment may coexist together, but far too many people have an extrinsic attitude toward nature and even their fellow humans. Shallow Ecology not only fails to solve this issue but also instills a reluctance to face larger concerns concerning the well-being of all living creatures. A misunderstanding of the Deep Ecology position, which is anti-human. Although deep ecology begins with the assertion that human intervention with nature is excessive, this does not imply that people must be destroyed. Nature is not out of control for humans, and humans should not be secluded from the environment. Cultivating a new attitude, as well as learning and adopting Deep Ecology ideas, must be a priority (Elechi, 2020; Maksum, 2021; Petrus & Louw, 2015).

Education for Sustainable Development

Education for Sustainable Development (ESD) aims to promote sustainable and responsible action towards the environment through education that originates from complex interactions between humans and the environment (Helen Kopnina, 2020). Sustainable education is very important because of the global challenges facing humans such as climate change and loss of biodiversity (Akman, Karaaslan, & Bayram, 2022; Samur & Akman, 2023). Education for sustainable development can train students to become agents of change who consider the long-term impact of the decisions they make on the environment. ESD can be implemented through the practice of skills such as problem-solving, critical thinking, and collaboration, which are necessary to formulate innovative and sustainable solutions. ESD does not just stop at theoretical knowledge but also inspires concrete actions that support sustainable development goals. The integration of deep ecological values in sustainable education, especially through student-centered learning through a constructivist approach, can be an effective strategy for achieving educational goals for sustainability. Deep ecology, through the eight key principles that have been established (Naess, 2019), is believed to be able to provide direct experience with nature and broaden the understanding that all living things have the same intrinsic value, which is not solely assessed from the perspective of human use alone (Taylor et al., 2017). In this way, students are expected to be prepared to become environmental protection agents and promote awareness of the urgency of preserving the earth's ecosystem. This research is a preliminary study to analyze the scale of students' concern for other creatures in the environment (eco-centric) which will later become material for developing learning instruments to increase students' environmental caring attitudes in depth in the Islamic boarding school environment.

Cased Study Deep Ecology in Boarding School (Pesantren)

Indonesia has 39,432 Islamic boarding schools with a total enrollment of 4,077,152 male and female students

(EMIS, 2022). These Islamic boarding schools may be found across Indonesia, including hilly places, coastal areas, tiny islands, distant rural areas, and metropolitan areas. As educational institutions, Islamic boarding schools play a critical role in influencing students' beliefs and attitudes. Islamic boarding schools are different from public schools because students (*santri*) live in the school environment 24 hours, 7 days a week. Students generally have a strict schedule of activities in studying religious education, pure sciences, applied sciences, arts, entertainment, sports, history, and literature. They receive intensive religious education such as the Qur'an, Hadith, Fiqh, and other religious knowledge.

The deep ecology research, especially those with an ecocentric mentality background, can be of special attention in Islamic boarding schools in Indonesia. Islamic boarding schools may become agents of change by comprehending and applying the eco-centric notion of deep ecology, which directs students' thinking and activities toward environmental sustainability. Indonesia has great natural richness, but it also confronts significant environmental difficulties. Deep ecology may assist in developing educational techniques that are suited for the local setting, by connecting eco-centric principles with local wisdom and Islamic boarding school culture. This is critical to preserve a balance between natural richness and sustainability, as well as to ensure that ecological awareness is interwoven with the religious and cultural values practiced in Islamic boarding schools.

The deep ecology approach helps students at Islamic boarding schools develop their character and mental health. An eco-centric attitude encourages individuals to have a better connection with nature, develops a sense of responsibility, and motivates them to contribute to environmental preservation. Deep ecology-based education can help to raise a generation that is not just academically competent, but also ecologically concerned and conscientious (Clark, Susan, 2019). Deep ecology-based education in Islamic boarding schools can also support sustainable development goals. By engaging students in a deeper understanding of the relationship between humans and the environment, Islamic boarding schools can play a role in developing future leaders who are aware of sustainability and prepared to overcome complex environmental challenges. This article presents the findings of students' eco-centric views in Islamic boarding school environments in Indonesia as preliminary data for implementing environmental education based on local values and the deep ecology framework.

Method

This research measures the student's attitude towards the environment level of Islamic boarding school students and the factors that influence it. This research seeks to answer the questions:

1. What is the student's attitude towards the environment (eco-centric, anthropocentric, environmental apathy, and sustainable lifestyle)?

2. How do demographic and psychographic characteristics of respondents (age, gender, parents' education, and parents' occupation) influence attitudes towards sustainability among student Islamic boarding schools (eco-centric, anthropocentric, environmental apathy, and sustainable lifestyle)?

This research involved 240 Islamic boarding school students located in distant rural and metropolitan areas in Indonesia, as respondents for data collection using survey methods. The research instruments were delivered to respondents online and offline with the help of biology teachers, school principals, and leaders of Islamic boarding school foundations. Using the deep ecology spectrum (Smith & Gough, 2015) based on the eco-centric and anthropocentric attitudes toward the environment scale questionnaire (Table 2) (Helen Kopnina, 2013), the first question will be answered. Furthermore, we used descriptive statistics to describe the relationship between student characteristics and sustainable attitude variables. We categorized the results of the questionnaire items as very high ($\geq$ 90), high (75 - < 90), high enough (65 - < 75), low (55 - < 65), and very low (< 55) (Tegeh, et al., 2014).

Deep Ecology Measurements

The concept of deep ecology (Naess, 2019) is implemented in a more specific field through seven deep ecology norms. The eco-centric view in Deep ecology was then elaborated into the practice of sports and physical activity (Breivik, 2019). The following are the seven norms of deep ecology and their descriptions.

Table 1. Seven Norms of Deep Ecology

Deep Ecology Norm	Description
Self-Realization	Avoiding the 'small self', that is, the narrow individual, the ego, only considering the individual's body, and making a broader and deeper self', that is, the social and ecological self.
Diversity	Diversity includes not only humans but also living creatures, ecosystems and landscapes.
Complexity	Focuses on qualitative distinctions rather than surface 'complications'
Symbiosis	Respect between diverse cultures and communities, coexistence of humans and the entire ecosphere.
No centralization	Decentralized decision-making, environmental decision-making is more dispersed and involves the participation of numerous stakeholders.
Autonomy	Each species in an ecosystem has intrinsic value, the right to live, the right to exist and develop autonomously. Nature has freedom (independence) from the benefits provided to humans, and develops without having to be measured in the context of its usefulness for humans.
No Exploitation	Do not take advantage of nature for selfish benefit. Avoid using natural resources excessively or destructively for human advantage solely.

Sources: (Breivik, 2019; Naess, 2019)

The seven deep ecology norms are translated into an instrument for measuring deep ecology variables (Helen Kopnina, 2013) with a scale named "Eco-centric and Anthropocentric Attitudes towards the Sustainable

Development (EAATSD scale). The EAATSD scale was developed from the Eco-centric and Anthropocentric Attitudes toward the Environment (EAATE scale) measurement scale which is the focus of deep ecology research. In this study, the EAATSD measurement scale was also used and analyzed because it is related to other research variables (SDGs). EAATE and EAATSD use a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree). The following are indicator items and statement items on the EAATSD measurement scale.

Table 2. Deep Ecology Assessment through the Eco-centric and Anthropocentric Attitudes Toward Sustainable Development (EAATSD)

Scale of evaluation	Description	Statement Items	Answers				
			1	2	3	4	5
Eco-centric	Appreciation of nature, separate from the benefits it provides to humans. A high score on the Eco-centric subscale indicates a great appreciation for the environment and positive physiological changes when in nature.	• One of the worst things about overpopulation is that many of the degraded natural areas are being destroyed to make way for development. • Sometimes it makes me sad to see forests being cut down for agriculture • I prefer wildlife sanctuaries to zoos. • One of the most important reasons for conservation is to preserve wild areas. • Nature is valuable for its own sake. • It saddens me to see the natural environment destroyed. • Humans are part of the ecosystem like other animals.					

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Scale of evaluation	Description	Statement Items	Answers				
			1	2	3	4	5
Anthropocentric	Measures appreciation of nature, but is also related to the quality of life and human survival. A high score on indicates a selfish concern for the way the environment affects the quality of human life.	• The worst thing about losing tropical forests is that it will limit the development of new medicines. • It bothers me that humans are running out of fuel supplies • Science and technology will ultimately solve the problems of pollution, overpopulation, and resource depletion. • The most important reason for conservation is human survival. • One of the best things about recycling is that it saves money. • Nature is important because it can contribute to human enjoyment and well-being. • We need to conserve resources to maintain a high quality of life.					
Environmental Apathy	Measures distrust of the reality of environmental problems and lack of interest in these problems. A high score on the Environmental Apathy subscale indicates a strong apathy towards environmental problems.	• Environmental threats such as deforestation and ozone depletion have become excessive • In my opinion, the problem of depleting natural resources is not as bad as many people think.					

Scale of evaluation	Description	Statement Items	Answers				
			1	2	3	4	5
Sustainability attitudes	A measurement scale to test eco-centric and anthropocentric values related to sustainable development The statement items are adapted or part of the EAATE scale	• Most environmental problems will resolve themselves if given enough time. • I am unconcerned about environmental issues. • I oppose programs to preserve wilderness, reduce pollution and conserve resources. • Too much attention is paid to conservation. • I do not feel that humans depend on nature for survival. • I think most conservationists are pessimistic and paranoid. • Humans are justified in drilling for oil to meet economic needs, even though it has a bad impact on the environment (-) • The most important reason to keep lakes and rivers clean is so that people have drinking water (-) • Nature is valuable for its own sake, independent of human interests (+) • Animal rights are as important as the rights of					

Scale of evaluation	Description	Statement Items	Answers				
			1	2	3	4	5
		women, minorities and others (equality issues) (+) • The thing that worries me most about deforestation is how many species may be threatened by it (+)					

Source: Adopted Kopnina (2013)

Results

Students' Attitude Towards the Environment

In this section, the results of the questionnaire regarding the environmental care attitudes of high school boarding school students are described. The attitude of caring for the environment in this section is related to the concept of deep ecology. The following are the results of calculating eco-centric, anthropocentric, and apathetic attitudes toward the environment with each indicator.
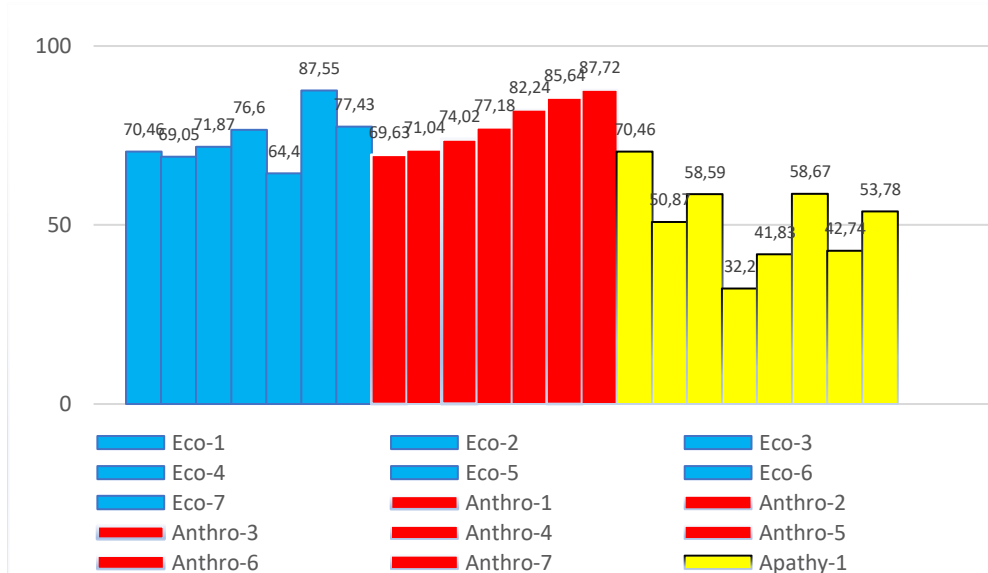
Figure 1. The result of the EAATE Questionnaire

In the eco-centric attitude assessment instrument, there are seven indicator questions to measure it. The sixth indicator had the highest score from 240 students who filled in answers stating "they are sad or don't like it when they see the natural environment destroyed." Meanwhile, the lowest score in the students' eco-centric measurement was the fifth indicator that "nature is valuable for its own sake" (Fig.1, Table 2). In the student

anthropocentric assessment, three statements had a score above 80, namely anthropocentric number 7 that "We need to save resources to maintain a high quality of life", anthropocentric number 6 "Nature is important because it can contribute to human enjoyment and well-being" and anthropocentric number 5 that "One of the best things about recycling is that it saves money". In assessing apathy towards the environment, almost all indicators had low scores ranging from 32.2 to 58.67 (Fig.1, Table 2). The following are the results of the average assessment scores for eco-centric, anthropocentric, and environmental apathy attitudes of students.
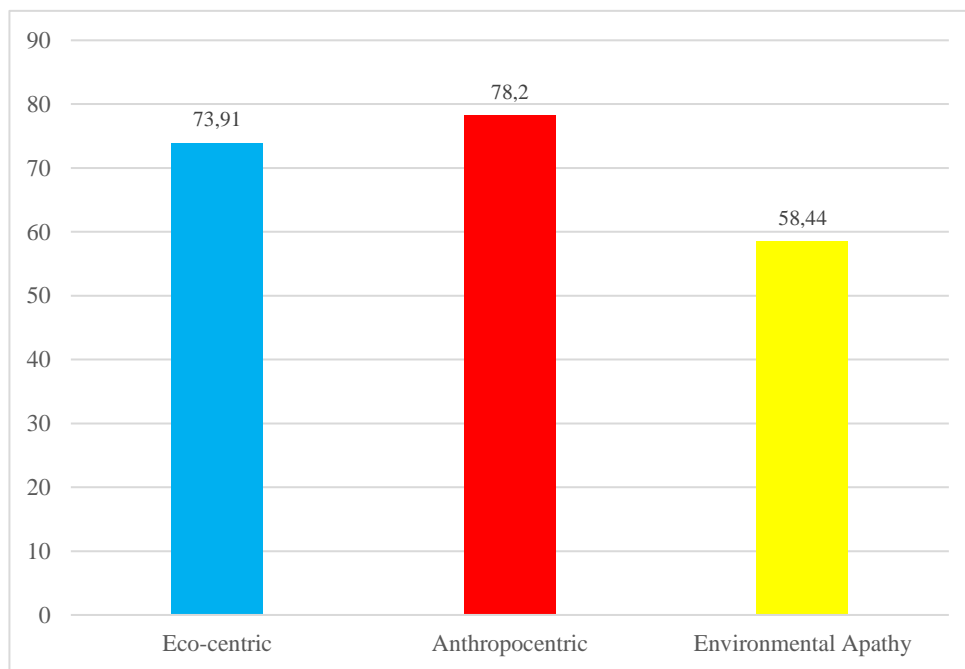
Figure 2. Mean Eco-centric, Anthropocentric, and Environmental Apathy Scores

The results of research from 240 student respondents indicate that anthropocentric attitudes have the highest average, namely 78.2 in the high category. Meanwhile, the eco-centric attitude of students was 73.91 in the high category. Apathy towards the environment has a value of 58.44 in the low category. The categorization of mean values for eco-centric, anthropocentric, and environmental apathy attitudes is adapted from Tegeh et al. (2014). Students have a caring attitude towards the environment and are more inclined to utilize nature for human survival.

The first research question we discussed using a list of statements on the EAATE scale (Eco-centric and Anthropocentric Attitudes Against the Environment). We analyzed the results of students' answers and determined. The EAATE scale consists of three subscales: 1) eco-centric, which measures appreciation of nature separated from the benefits it provides to humans. 2) anthropocentric, measuring appreciation for nature, but also related to the quality of life and human survival, and 3) environmental apathy. We recorded respondents' responses and determined the relative value of the human versus non-human world (other living things) or the deep ecological spectrum (figure 1).
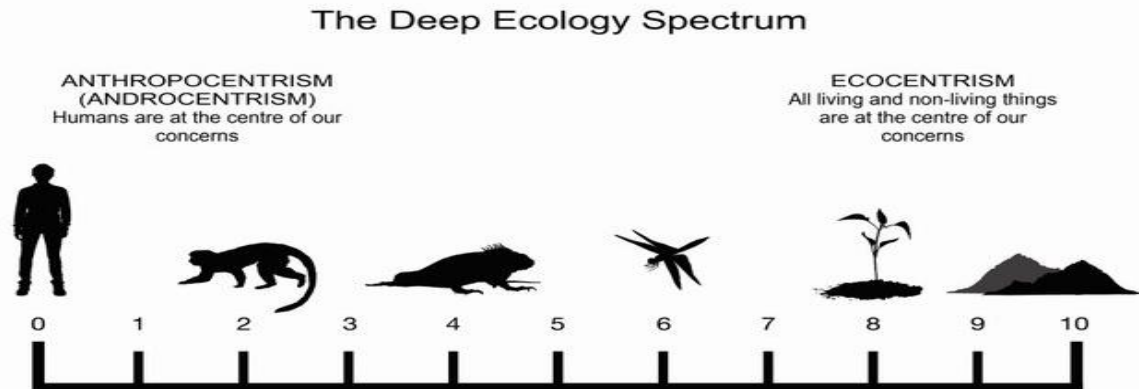
Figure 3. The Deep Ecology Spectrum (Copyright HR Smith 2015)

Students' eco-centric attitude has a score in the range of 7 to 8, which means that they care enough about all living and non-living creatures in the environment. However, if an anthropocentric measurement is carried out using the deep ecology spectrum, it is also in a high range of values, a score between 2 and 3, which means that the respondent has egoism as a human who uses all living and non-living creatures for his benefit. Referring to the research results (figure 3), anthropocentric attitudes were detected to have a higher value than eco-centric.

The Students' Sustainability Attitudes

The instrument for measuring students' sustainability attitudes is adapted from eco-centric, anthropocentric, and environmental apathy attitudes. The instrument contains five indicators with positive and negative statements. The following are the results of measuring students' sustainability attitudes.

Table 3. Data on Students' Sustainability Attitudes

	Items	Mean
	Humans are justified in drilling for oil to meet economic needs, even though it has a bad impact on the environment (-)	56.35
	The most important reason to keep lakes and rivers clean is so that people have drinking water (-)	39.67
Sustainability attitudes	Nature is valuable for its own sake, independent of human interests (+)	49.88
	Animal rights are as important as the rights of women, minorities and others (equality issues) (+)	61.66
	The thing that worries me most about deforestation is how many species may be threatened by it (+)	74.94
	Total average	56.50

The assessment of students' sustainability attitudes turned out to have a mean score of 56.50 in the low category. The lowest value is owned by items treating nature that have intrinsic value, apart from their usefulness for

humans. They consider that other living and non-living creatures are for human welfare, for example in terms of drilling for oil for economic needs, as well as utilizing water sources to fulfill human needs. The student's score in considering nature as valuable for themselves is in the very low category, namely 39.67. Meanwhile, the highest value for the item loss of species due to deforestation with a value of 74.94 is in the sufficient category (Table 3). Based on the results of this research, respondents have a relatively low sustainability attitude. Apart from that, it requires habituation or learning to continue to increase the attitude of caring for the environment beyond the benefits it provides for humans (intrinsic value).

The Relationship Between the Mediating Variables with the Latent Variable of Students' Attitudes Toward the Environment

This section attempts to explain other variables that can influence the formation of environmentally caring attitudes. In general, these variables are in the form of the student's background which includes age, gender, education, and occupation of the student's parents. The following is demographic data from 240 respondents.

Table 4. Respondent Characteristics

Variables	Frequency	%	Variables	Frequency	%
Age			**Parents' education**		
14 years old	3	1.24	**Father**		
15 years old	54	22.41	Elementary-Middle School		
16 years old	104	43.15	Senior High school	120	49.79
17 years old	72	29.88	Bachelor	79	32.79
> 17 years old (18,19 yo)	8	3.32	Master	34	14.11
Gender			Doctoral	8	3.32
Men	118	48.96		0	0
Women	123	51.04	**Mother**		
Parent's occupation			Elementary-Middle School		
Father			Senior High school	138	57.26
State employees	27	11.21	Bachelor	73	30.29
Employee	169	70.12	Master	29	12.03
Self-employed	37	15.35	Doctoral	1	0.42
Retired/not working	8	3.32		0	0
Mother					
Housewife	146	60.58			
Employee	14	5.81			
Teacher	15	6.22			
Self-employed	66	27.39			

Demographic data from all respondents informs that the students in this study ranged in age from 14 to 19 years old, with the highest percentage of respondents aged 16 years at 43.15%. The percentage of female students is around 2% more than male students. The type of work that fathers do is dominated by private sector employees or civil servants at 70.12%. Meanwhile, the dominant occupation of mothers is as a housewife as much as 60.58%. Parental education, both father and mother, is mostly at the elementary-middle school level (Table 2).
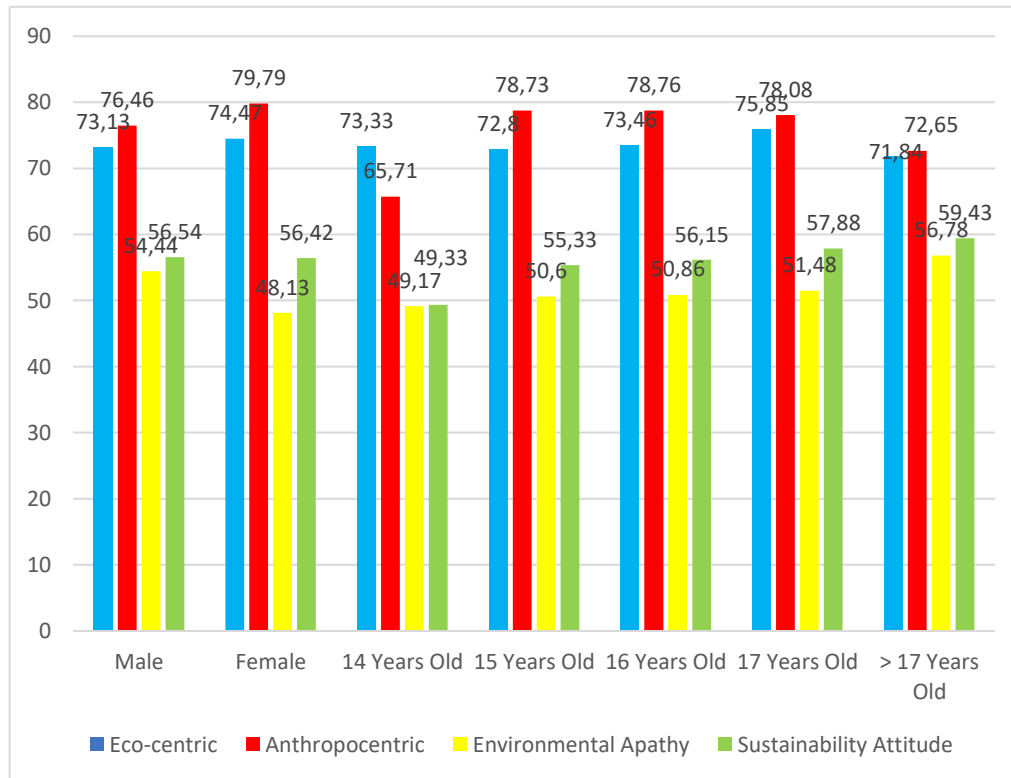
Figure 4. Students' Sustainability Attitudes Based on Students' Gender and Age

Based on gender, both male and female students have eco-centric scores in the quite high category of 73.13 and 74.47. The anthropocentric attitude of female students is 4 points higher than that of male students with both being in the high category (scores 79.79 and 76.46). Apathy towards the environment for both male and female students is in the very low category or in other words, they care quite a lot about the environment. However, the attitudes of male and female students towards sustainability issues are also in the low category. With students' high anthropocentric attitudes and low levels of apathy and attitudes towards sustainability issues, it can be interpreted that students care about the environment and other living creatures because of their benefits for humans. Students aged 15, 16, and 17 years had the highest scores for anthropocentric attitudes. However, students aged 17 years had the highest score for eco-centric attitudes in the "high" category (75.83) while other ages were in the "fairly high" category. The least concerned attitude towards sustainability issues is owned by 14 and 15-year-olds in the very low category, while the others have the "low" category.
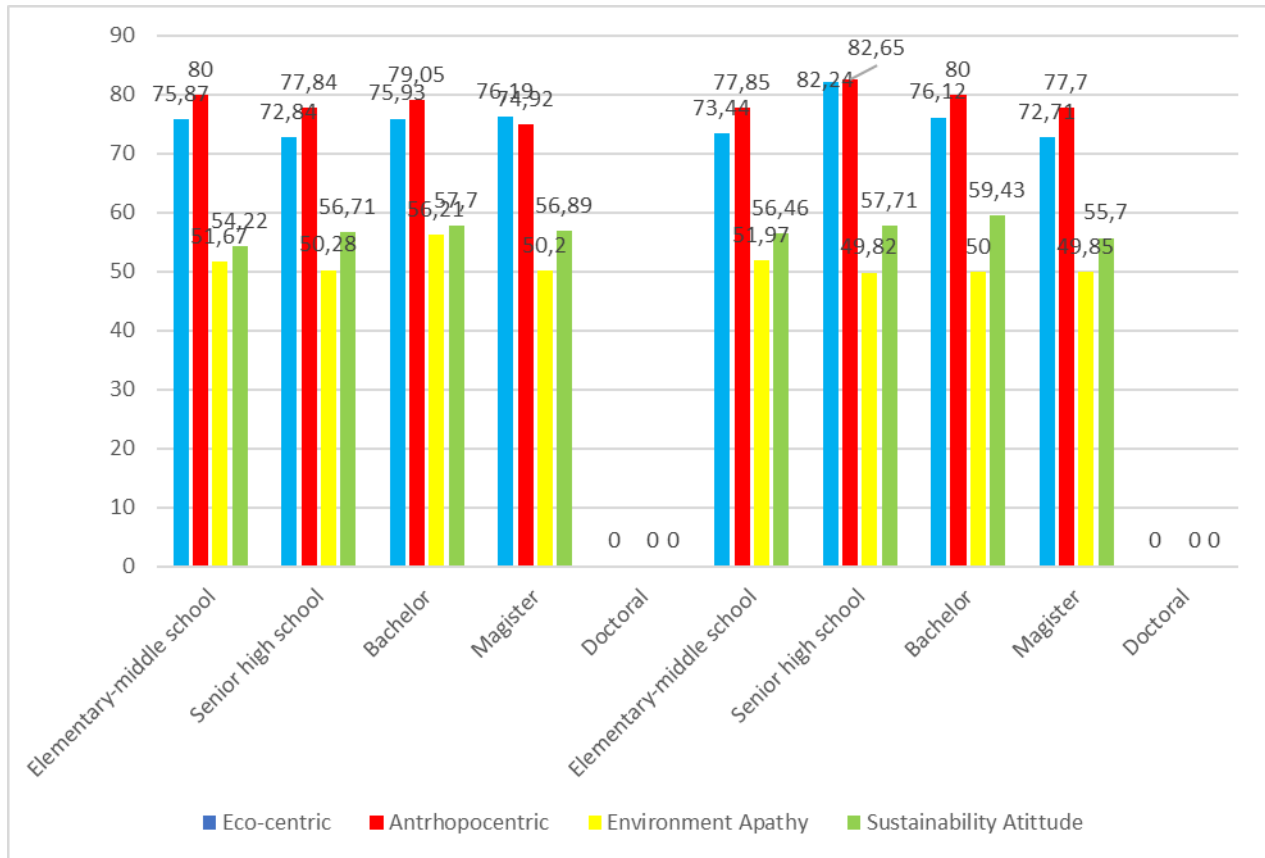
Figure 5. Sustainability Attitudes Based on Parent's Education (Father, Left), (Mother, Right)

The education of students' parents, both father and mother, in this study was grouped into four categories, namely 1) Elementary-Middle School, 2) Senior High School, 3) Bachelor's, 4) Master's, and 5) Doctoral. In the eco-centric attitude assessment, students with mothers with senior high school education had the highest score (76.12) in the "high" assessment category. Furthermore, students with fathers with master's degrees had the highest assessment scores for eco-centric attitudes with a value of (76.19) in the "high" category. The anthropocentric attitude of students is highest with mothers with senior high school education, and fathers with elementary-middle school education. Apathy towards the environment is highest among students with mothers with elementary-middle school education and fathers with bachelor's degrees. Meanwhile, students' attitudes towards sustainability issues are highest with mothers with bachelor's degrees and fathers with master's degrees. Neither male nor female students were found in the sample of parents with doctoral education.

Discussion

The attitude of caring for the environment in students in this study was measured using eco-centric, anthropocentric, and environmental apathy instruments. Students tend to have opinions or attitudes about using the environment for the benefit or welfare of humans. This is reflected in the lowest eco-centric assessment indicator in the statement "Nature is valuable for its own sake". Students do not agree that nature is valuable for

itself and tend to have the principle that nature is valuable for human interests. Apart from that, the highest average score is found in the assessment of anthropocentric attitudes, which means appreciation of nature, but this appreciation is related to the quality of life and human survival. A high score on the anthropocentric assessment indicates a tendency towards egoism and the view that the environment is aimed at the quality of human life (Erdaş Kartal & Mesci, 2022; H Kopnina, 2012; D Molina-Motos, 2019).

The results of the analysis of student characteristics including age, gender and parents' education in this study were analyzed for their relationship to students' attitudes towards sustainability issues (eco-centric, anthropocentric, environmental apathy). In general, gender has the same category for all assessments. Meanwhile, the respondent's age. Several studies state that gender does not have a significant effect on a person's attitude towards the environment (Mostofa, 2006; Dhenge, et al., 2022; Wut, et al., 2021). The youngest respondents (14 and 15 years old) had the lowest ratings of caring attitude towards sustainability issues. Meanwhile, the highest eco-centric attitude is possessed by students with a relatively high age (17 years) in the "high" category. This shows that students' age relatively determines their attitudes towards the environment (Fielding & Head, 2012). This research also analyzes the relationship between parents' education and their attitudes towards the environment. As a result, some data supports that parental education has quite an influence on attitudes towards sustainability issues. For example, in research data, a student with a father with an elementary-middle school education had the highest score in anthropocentric attitudes (human egoism towards the environment). However, learning environment (school) factors also influence students' attitudes towards sustainability issues (Misseyanni, 2020). This research has a weakness in that it has not yet exported school environmental factors such as curriculum, educational facilities and infrastructure, and habituation activities in the Islamic boarding school environment.

Conclusion

The anthropocentric attitude of Islamic boarding school students is more valuable than the ecocentric attitude, even though both are in the top category. Meanwhile, environmental indifference is rather low. As a result, pupils care about the environment since the natural world is necessary for survival or human needs. However, research respondents are not very concerned about environmental sustainability. This is reinforced by the findings of studies on students' attitudes toward sustainability concerns, which are rated as poor. Age and parental education are two student characteristics that have a significant impact on their opinions.

Recommendations

Future research should be completed by exploring education and the environment in Islamic boarding schools. This can include the curriculum, supporting educational facilities and infrastructure, and typical habits or culture in Islamic boarding schools which are related to forming a caring attitude towards sustainability.

Acknowledgments

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Trend of Microbiology Literacy: Systematic Literature Review

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Abstract: Microorganisms can be found in every part of the environment. They are found in the air, surfaces of objects, and various other ecosystems. Even our lives cannot be separated from the existence of microorganisms. Microbial communities and their metabolites can have positive and negative impacts. Even the Health sector has evaluated and reviewed the role of microorganisms in health, by including microorganisms in prevention and treatment protocols. Microbial communities can cause or exacerbate the spread of disease, including the fact that microorganisms have been the cause of pandemics in recent years, but some communities can reduce disease. Several articles have attempted to reflect on the presence of microorganisms and their urgency in supporting the life and health of living creatures. This phenomenon was the beginning of the emergence of microbiology literacy. Few articles still examine the explicit relationship between microbiology literacy and social and educational issues. This article aims to define the concept of microbiology literacy academically and provide relevant references on aspects of microbiology literacy's definition. Theoretical concepts are prepared based on article studies, exploration, and systematic analysis.

Keywords: Microbiology Literacy, Microbiological Literacy, Microbiology Trend, SLR

Introduction

There are many microorganisms present in the environmen [1] t. The existence of microbes cannot be separated

or even excluded from our life [2]. The role of a microorganism is extremely various, and there often is an advantageous link between them and human well-being and health. Food ingredients are manufactured and fulfilled in part by microorganims [3], possess an effect on public health [4], encourage the development of a wholesome atmosphere [2], sustains the system of the biosphere [5], contributes to nitrogen fixation [6], [7], contributes to carbon fixation [8], decompotition [9], biogeochemical cycles [10], biotechnology [11], bioindustry and renewable energy [12], antibiotics [13], [14], and bioremediation [15], [16].

Learning microbiology in the 21st century requires more than just acquiring knowledge, it also entails expanding one's vocabulary [17], improving literacy [5], acquiring life skills [18], using of technology [19], and pursuing sustainable development objectives [20]. This implies that developing learning abilities in microbiology will center on modifying people's behavior and producing [21].

A strong foundation in reading and numeracy is something that every youngster needs. Microbiology is among the numerous academic disciplines where literacy is growing. The primary issue is that research must be conducted independently to fully discuss each subject. It is crucial for this study to incorporate microbiology literacy into scientific literacy, which emphasizes the importance of the microbiology context. By offering a theoretical and comprehensive definition of microbiological literacy, this study seeks to close the gap between various conceptualizations of the notion. This article's primary goal is to highlight the microbiology literacy research trends of the past five years. This research aims to bridge the gap between several conceptualizations of microbiology literacy, while providing a theoretical and integrated concept of microbiology literacy.

Method

It is intended that the literature evaluation, which is conducted using a literature review process, will offer pertinent references to the various facets of the microbiology literacy sector. In this study, many questions are raised, including:

RQ 1   **:** What is the function of "microbiology literacy"?

RQ 2   **:** Which literacy components are included in the field of microbiology?

RQ 3   **:** What are the details of the microbiology theme that is being studied for the "microbiology literacy" credit?

RQ 4   : Who is the subject of the "microbiology literacy" research study?

Mechanism for Literature Search

In February 2024, the search process provided 12 articles and 9 of them were relevant. We use keyword "microbiology" and "literacy" on the Scopus database. Due to the inadequacies in the field of microbiology because of the search for information literacy, few results were found. This does not, however, lessen the significance of this study endeavor. Mechanism for literature search shown in Figure 1. The search history on

Scopus database is TITLE-ABS-KEY (microbiology literacy) AND [LIMIT TO (DOCTYPE, "ar")] AND [LIMIT-TO (SUBJAREA, "soci")] AND [LIMIT-TO (PUBSTAGE, "final")] AND [LIMIT-TO (LANGUAGE, "english")] AND [LIMIT-TO (OA, "all")].

Identification
Search articles using Scopus database using keyword "Microbiology' and " Literacy"

Screening
- Subject area non-social science
- English only
- Article only
- Open access article only

Eligibility
Article published from 2020 to 2024 and phase "final stage"

Included
Articles relevant to the research theme (n=9)
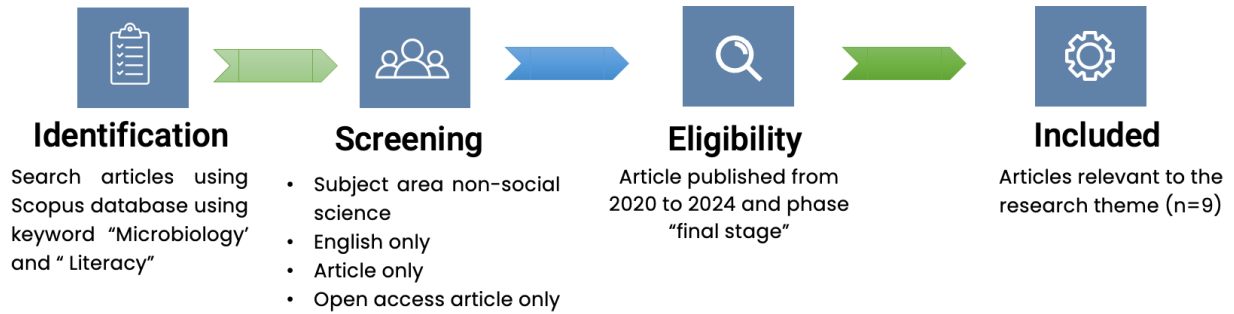
Figure 1. Mechanism for Literature Search

Criteria of Inclusion and Exclusion

Table 1 outlines the inclusion and exclusion criteria used in this investigation. Not included were any articles that are not specifically related to the topic of research. The next step is to review the abstract to make sure the research question is addressed in the paper.

Table 1. Criteria for Inclusion and Exclusion

Criteria	Concept	Contain "Microbiological Literacy" as subject in Scopus collection
Inclusion Criteria	Type of document	Article
	Availability	Open access
	Year	2020 - 2024
	Language	English
Exclusion Criteria	Concept	Not contain "Microbiological literacy" as subject in Scopus collection
	Type of document	Books, proceeding
	Availability	Non – open access
	Year	Before 2000
	Language	Non-English

Results

The field of microbiology is not something that is new. On the other hand, the scientific field of microbiology is developing at a faster rate than technology. We found that, although they are not hard to get by, there are still

not many articles on the topic of microbiological literacy. Readers can learn about the last five years of microbiological literacy research from this article.

13 papers that emerged from the search, 4 of them were proceeding, and only 9 of them satisfied the criteria for inclusion. 9 materials were chosen, and upon examination, the findings were pertinent to research questions. Documents pertaining to microbiological literacy were determined to be few in quantity. The article search results are shown in Table 2.

Table 2. Information from Article Analyzed

No	Year	Authors	Country	Components	Function	Theme	Subject
1	2023	Joynera [25]	USA	Focuses on creasing pedagogy that incorporates information literacy, communication literacy, and STEM literacy through a range of projects and research activities	Future career	Human of Microbiome (Introduction)	College
2	2023	Brandaro [26]	Brazil	Focuses on scientific literacy studies in a series of workshop activities through innovative learning approaches	Learning approach	Food Safety	Elementary School Students and Junior High School Students
3	2023	Lloyd [27]	Australia	Focus on communication literacy and digital literacy through a	Learning approach	Infection & Vaccines	Health Science College

				social contructivist learning approach using podcast			
4	2023	Rhool [28]	Multiregion (USA, Kanada, Kroasia)	Focus on scientific literacy and information literacy through active learning strategies	Learning strategy	Immunology	College
5	2022	Smyth [29]	USA	Focus on STEM literacy, civic literacy, scientific literacy, and information literacy through e-portfolio	Learning approach	Diversity of microbes	Microbiology Course
6	2020	Torres [30]	USA	Focus on health literacy	Identify HPV teaching curricula	Human Papilloma Virus (HPV)	Dentistry College
7	2022	Morra [31]	USA	Focus on scientific literacy and information literacy through guest lecture strategies with experts	Measure perception of the Covid-19 vaccine	Covid-19	Non-STEM College
8	2024	Karayanni	Grecee	Focus on scientific literacy and health literacy	Microbiology awareness purposes	Microbes	Microbial Ecology Course

9	2023	Timmis	Jerman	Focus on information literacy and microbiology literacy	Curriculum development	Teaching resources for iMILI (International Microbiology Literacy Initiative)	Microbiology curriculum

1. The Function of Microbiology Literacy

The results of the articles analysis showed that the role of microbiology literacy in research over the past five years has been to 1) for future careers, 2) serve as learning approaches, 3) serve as learning strategies, 4) identify and develop curricula, 5) measure perception, and 6) foster self-awareness, as shown on Figure 2. Mastery of skills and competences is relevant to future professional growth; therefore, motor exercises are typically added to this objective. Meanwhile, microbiology learning approaches and strategies are presented involving an interesting, challenging, and fun learning process.

Its use as a tool for curriculum identification and development involves a critical mapping of the content offered, the most recent content, and its connections to other forms of literacy. The types of literacy involved are discussed in the second research question. In measuring microbiology literacy for the purpose of measuring perception, there is a tendency to measure knowledge related to microbiology phenomena in everyday life. Several articles involve the Covid-19 pandemic, vaccine developments and the level of public trust in vaccines. Research relating to microbiology awareness purposes and focusing on socio-scientific phenomena is presented in relation to health literacy and scientific literacy.
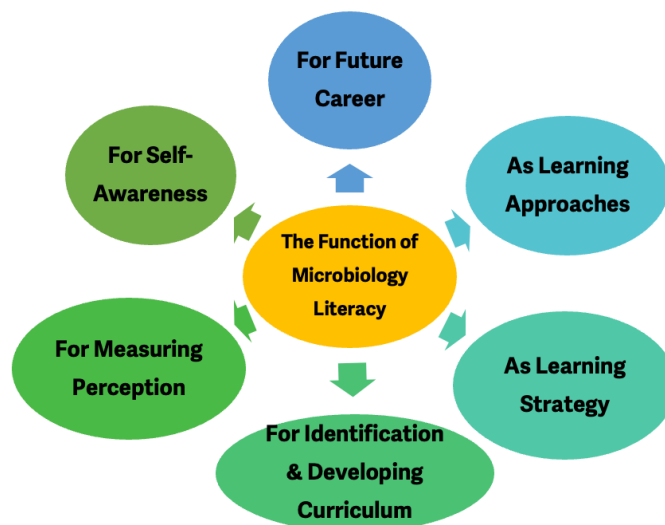
Figure 2. The Function of Microbiology Literacy

2. The Literacy Component Associated with the Field of Microbiology Literacy

Based on the study of articles, the literacy components associated with the field of microbiology literacy is 1) STEM literacy, 2) information literacy, 3) communication literacy, 4) scientific literacy, 5) digital literacy, 6) civic literacy, and 7) health literacy as shown at Figure 3.

Figure 3. Component of Microbiology Literacy

3. The Topic of Study on Microbiology Literacy

It was discovered that the topics covered in microbiology literacy research were 1) microbial diversity, 2) food safety, 3) immunology, 4) microbial concepts, and 5) microbiology curriculum in an analysis of publications published in the Scopus database over the previous five years, as shown on Figure 4.
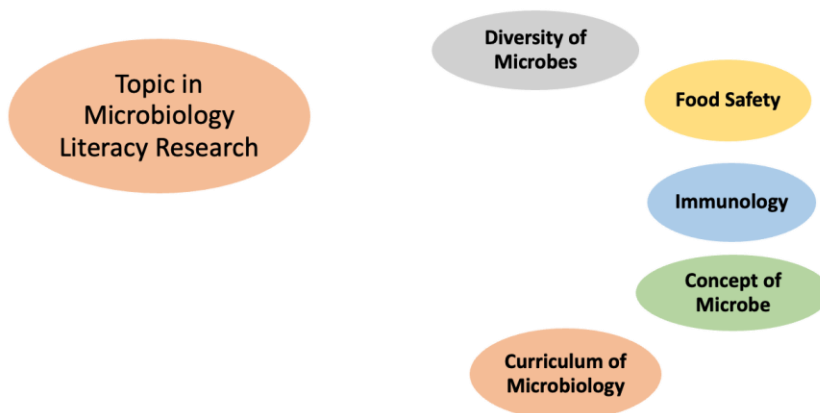
Figure 4. Topic of Microbiology Literacy Research

4. The Subject of Microbiology Literacy Research

The following populations have been the focus of microbiology literacy research over the past five years: 1) students in elementary school; 2) students in middle school; 3) students in high school; 4) students at universities; and 5) a variety of microbiology courses, as shown on Figure 5. Research on kindergarten and preschool age groups is rare. This possibility can occur because there is no written report that can be detected. It is possible to do research on young children to try to influence their behavior. Behaviors related to the introduction of normal flora, hygiene, and microbiology awareness. Additionally, there is a lack of research material about microbiological literacy among the elderly. These days, a lot of illnesses that affect the elderly are linked to lifestyle choices, such as obesity. The imbalance of gut microbiota, which affects obesity, has been the subject of numerous research. Both adult and pediatric obesity are frequently linked to an elevated Firmicutes to Bacteroidetes ratio, which is a feature of obese children across different regions. Microbiology literacy studies can be expanded to target elderly humans.
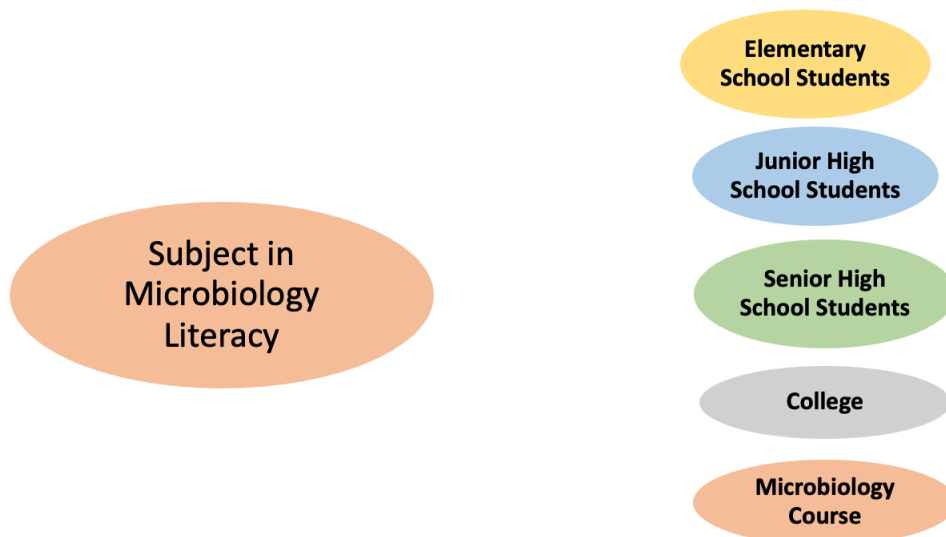
Figure 5. Subject in Microbiology Literacy Research

Discussion

A paper on the integration of microbiology with scientific literacy was published in 2014 [32]. This involved student participating in scientific inquiries using computers, problem-solving techniques, and laboratory inquiry. Timmis et al in 2019 defined microbiological literacy as the ability to understand pertinent microbial activities, including how microorganisms affect human life and how this affects life [34]. The goal of this essay subsequently became to present subjects related to microbiology that are included in the curriculum [22]. It is

said that children play a part in passing along new or evolving knowledge about microbiology to both family members and other people.

Microbiology literacy is not limited to students but is starting to be used as an effort to shape public perception. The International Microbiology Literacy Initiative seeks to provide comprehensive resources instrumental in establishing a socially relevant yet child-centered microbiology curriculum [5]. As microbiological literacy developed, it started to incorporate scientific, technology, engineering, and math (STEM) literacy using various methods [36]. In the future, the complexity of approaches will become increasingly diverse to achieve society's aspirations and update microbiology literacy. Since Timmis's thorough article on the need of microbiological literacy, there has been increased interest in this area of research. Even if the definitions of terms in microbiology literacy are not well defined, we are attempting to investigate the elements of microbiology literacy based on the evolution of publications during the previous five years.

Every environment has microorganisms [40], including extremely clean rooms and space stations [43]. The numerous and varied microbial communities found in household dust have been shown in research to be safe for human health [44]. The notion that early childhood exposure to microbes affects immune system development is similar. The prevalence of common physical and mental diseases is rising quickly in today's culture, primarily because of a lack of exposure to immunoregulatory microbe [45]. There are probably biological pathways that raise the risk of inflammation and related health issues for those who live in surroundings with little microbial exposure [44].

Productivity [42] and economic efficiency [49] are significant objectives in literacy knowledge and comprehension. One way to think of economic research is as long-term business models. Industry has a significant impact on pollution, maintaining the earth's climate [50], and raising greenhouse gas emissions. Numerous industries can benefit from the solutions provided by microbiology. For example, yeast can lessen haze formation in the manufacturing of packaged wine [51] produce valuable goods for the fermentation business [52] and enable sustainable bioremediation [53]. The application of microbiology is crucial to the establishment of a sustainable economy.

We use Scopus database only from 2020 to 2024 and English article only. There is a possibility that the number of articles found will increase over time. Data collection was carried out in February 2024. This research relies on Scopus data and is limited to articles that can be accessed openly. There is a possibility that other articles can be found that can provide other important information. More wide database sources can be used in future study to gather more detailed data.

Conclusion

1. Research during 2020 – 2024 showns the function of microbiology literacy research is for a) for future

career purposes, b) as learning approaches, 3) as learning strategy, 4) for identification & developing curriculum, 5) for measuring perception of microbiology, and 6) for self-awareness.

2. Literacy components involved in microbiology literacy research are a) STEM literacy, b) information literacy, c) communication literacy, d) scientific literacy, e) digital literacy, f) civic literacy, and g) health literacy.
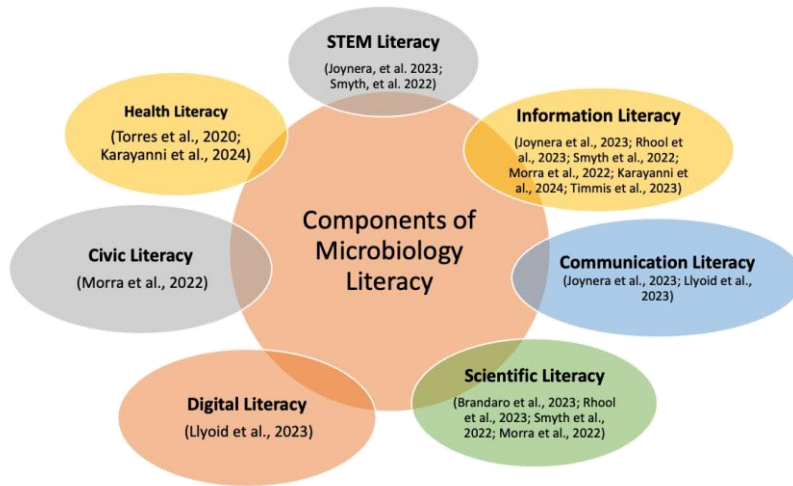
3. The topics in microbiology literacy research between 2020 to 2024 are a) microbial diversity, b) food safety, c) immunology, d) microbial concepts, and e) microbiology curriculum development.

4. The subject of microbiology literacy research between 2020 to 2024 is a) elementary school students, b) junior high school students, c) senior high school students, d) college, and e) microbiology course.

Recommendations

There are several calculated actions that may be made to raise microbiological literacy. One of these is the development of microbiological technology and knowledge that can support the circular economy in society. Examples of these include the employment of microbes to improve soil health and sustainability, bioremediation in the processing of garbage, and similar initiatives to address global issues. Even though it will take some time and money to improve microbial methods for commercial production, government, business, and academics can work together to make this happen. Achieving new policies necessitates a robust research community, interdisciplinary collaboration, and effective results distribution, particularly in social and political institutions.

Creating a model of microbiology literacy that is especially designed to measure the dimensional components of microbiology literacy is the general recommendation for future research. More research into the nature and mechanics of measuring is necessary to develop a solid knowledge of dimensional measures. Microbiology literacy research can also be directed at pre-school, kindergarten, and elderly children. Documents related to this research were not found by the author until this article was written.

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Project Based Learning Strategy as an Alternative Solution Domain Psychomotor in Virtual Islamic Boarding School

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Abstract: The purpose of this study was to explore the role and application of project-based learning (PjBL) strategies as an alternative to the psychomotor field in virtual Islamic boarding schools. The research method used is bibliographic research. Data collection techniques are documented. Data were analyzed using critical text analysis. The results of the study show that the role and application of project-based learning (PjBL) strategy as an alternative to the psychomotor field in virtual Islamic boarding schools can be realized because the strategy The PjBL learning strategy is focused on student learning. Project-based learning in virtual Islamic boarding schools can be implemented by adapting the technology used. This study has limitations, especially regarding the observed cases associated with virtual Islamic boarding schools. The study results provide insight into the role and application of project-based learning (PjBL) strategies as an alternative in the psychomotor field, especially in terms of fidelity, which is done using virtual learning. Virtual learning in Islamic boarding schools can also be used to develop the psychomotor field. A virtual learning design based on an Islamic boarding school can be implemented so that the goals of the learning implementation can be well achieved.

Keywords: Boarding School, Project Based Learning, Student Centered.

Introduction

The paradigm shift in Islamic boarding schools is progressing with the development of technology. Virtual Islamic boarding schools evolved into their ideal form over time. On the other hand, non-virtual Islamic boarding schools are evolving to find the best form to meet the development of technology and information. These two mutations lead to the needs and demands of society (Fakhrurrozi, 2021). The development of technology has had a huge impact on education (Acikgoz & Akman, 2023; Ozturk, 2023). Islamic boarding schools play an important role in the world of education which is also affected by technological developments.

Islamic boarding schools have played an active role in creating a quality generation through more practical measures (Baharun & Ardillah, 2019). Islamic boarding schools are Indonesian educational institutions that have long adhered to the empowerment system (Baharun & Ardillah, 2019).

Teacher-centered teaching is a learning model in which the teacher acts as the center of teaching and learning activities. In this model, teachers play a key role in determining the content, methods and learning processes carried out in the classroom. In teacher-centered learning, teachers are responsible for all decisions related to classroom learning, including determining curriculum, teaching methods, and assessing learning. Students are considered recipients of knowledge and must absorb what the teacher teaches.

This learning model has been controversial for many reasons. First, this model tends to limit students' creativity and initiative. Second, this model does not take into account students' individual needs and interests. Third, this model does not encourage students' active participation in the learning process.

As an alternative, several student-centered learning methods have been proposed. In these models, students are considered the center of learning activities and teachers act as facilitators or advisors who help students achieve their learning goals. According to this approach, students have more freedom in determining their learning goals and take a more active role in the learning process.

Teacher-centered teaching is a learning method in which the teacher is the center of the entire learning process. According to this approach, teachers are responsible for all instructional activities, including planning, implementing, and assessing learning. Students only act as receivers of information and instructions from the teacher.

Teacher-centered learning is often considered a less effective approach in improving the quality of learning. In fact, this approach tends to make students passive, only absorbing what the teacher teaches without encouraging them to think critically and creatively. In contrast, a more effective learning approach is student-centred, in which students are given a more active role in the learning process, for example by encouraging them to ask questions, discuss and work together in groups. This approach is considered more effective in improving students' critical thinking, creativity and collaboration skills.

The important role of Islamic boarding schools in education gives hope for the development of education. The efforts of Islamic boarding schools to keep up with technological developments are reflected in the websites of many Islamic boarding schools that provide online information about Islamic boarding schools. Islamic boarding schools collaborate with the Internet not only for socialization or marketing management but also for academic aspects (Fakhrurrozi, 2021). One aspect that shows similarities between virtual Islamic boarding schools and non-virtual Islamic boarding schools is the subject content and students (Fakhrurrozi, 2021). There is a need to improve the curriculum, review teaching materials, strengthen teacher human resources (especially

those specializing in IT) through diverse training courses, appropriate administrative arrangements and other Other technological advances. Through these "virtual Islamic boarding school" service points, information can be provided 24 hours a day, in addition to the credits specified in timetables and programs (Musthofa et al., 2021).

Each Islamic boarding school has different characteristics and teaching methods depending on the tradition, leader, and available resources. However, in general, education in Islamic boarding schools still tends to prioritize the role of the teacher or kyai in teaching. This is seen in school curricula that place more emphasis on learning through reading sacred books or religious texts, as well as in teaching methods that place more emphasis on memorization and repetition.

One learning strategy that can be used to overcome these challenges is project-based learning (PjBL). PjBL is a project-based learning approach in which students learn by undertaking a project or assignment that requires high-level thinking, creativity, and collaboration skills. This learning also allows students to develop psychomotor skills through the direct experience of making or creating something real.

Implementing PjBL learning strategies in virtual Islamic boarding schools could be an alternative to effectively develop students' psychomotor domains. In addition, PjBL can also help improve students' collaboration, creativity and critical thinking skills when facing the challenges of an increasingly complex world. Therefore, there is a need to conduct a literature review to further explore the application of PjBL learning strategies as an alternative to the psychomotor domain in virtual Islamic boarding schools.

Method

This study is a qualitative study with literary research. The research method used is bibliographic research. Data collection techniques are documented. Data were analyzed using critical text analysis.

Results

The research results show that the role and application of learning strategies Project Based Learning (PjBL) as an alternative solution to the psychomotor domain in Islamic boarding schools virtual can be done because the PjBL learning strategy is learning-centered to students. Project-based learning at virtual Islamic boarding schools can be implemented with adapting the technology used. Students can develop physical and motor skills through project-based learning. Additionally, students can develop collaboration skills and other social skills that can help them in real life. The psychomotor domain is the domain related to the ability or capacity to act after a person performs a certain learning activity (Mudhakiyah et al., 2022).

The research results provide an overview of the role and application of Project Based Learning (PjBL) learning

strategy as an alternative solution in the psychomotor domain especially in terms of honesty, it can be implemented with virtual-based learning. Virtual-based Islamic boarding school learning can also be used to develop domains psychomotor. A virtual Islamic boarding school-based learning design can be carried out to achieve the objectives of learning can be achieved well.

Discussion

Some Islamic boarding schools have converted and adopted a more student-centered approach to education. They integrate religious curricula with general courses, develop more active and participatory teaching methods, and provide broader space for student creativity and exploration. born. Therefore, the reproduction of Santri must be massively accelerated and expanded, so that the viable option is not only their existence in the real world but also their birth in the virtual world, on the Internet or in the so-called " global village" (Musthofa et al., 2021). Follow teachings based on the teachings of Salafussalah scholars and use technological devices now available to the wider community If Al-Ishlah Islamic Boarding School helps the people of Temanggung then it is hoped that the digital Islamic boarding school program can meet society's broader need for knowledge Islamic religion (Musthofa et al., 2021). The form of information technology development using learning media is distance learning, online or online learning (Andika et al., 2020).

As time passes and educational requirements become more and more complex, some Islamic boarding schools have begun to update their teaching methods and be open to innovation and change. Therefore, although it can be observed that education in Islamic boarding schools has always been teacher-centered in some Muslim boarding schools, it cannot be claimed that this is a practice that applies universally to all Islamic boarding schools. Most learning models in Islamic boarding schools are not very advanced, specifically the traditional model. On the other hand, very few e-books also support learning in Islamic boarding schools (Ma'sum & Syafaat, 2015). Therefore, this is a challenge for technological development in virtual Islamic boarding schools. Project-based learning is a learning method that emphasizes active learning and hands-on experiences, where students gain skills and knowledge through projects or assignments related to realistic context. Project-based learning is great for developing students' psychomotor aspects, especially physical and motor skills.

The psychomotor domain is the portion of learning outcomes that involve the application of basic skills and physical movement. The psychomotor aspect plays a very important role in human life. Developing these skills comes through study and practice. The psychomotor field also deals with motor or manual skills (Neno, 2023). Here are some tips for developing psychomotor aspects through project-based learning: (1) Choose a project that involves physical activities and movement. For example, students can build a model or design a prototype of a tool or object that involves the use of tools such as scissors, saws, etc. (2) Give clear and detailed instructions. Before starting a project, make sure students understand the instructions and tasks to be completed. Provide clear instructions on how they should use certain tools and materials used in the project. (3) Create opportunities to experience and try. Students need to be given opportunities to test themselves and develop their skills. Give

them advice and support to help them overcome difficulties or obstacles. (4) Provide constructive feedback. As students complete projects, provide feedback on their skills and techniques. Offer suggestions on how they can improve their skills and abilities. (5) Create opportunities for cooperation. Projects may require group work so students can learn to work together and appreciate each other's contributions. Collaboration can also help students develop their social skills. Projects provide a bridge between the material taught in the classroom and the real world, so that students' learning experiences form a unified whole (Khasanah & Darsinah, 2022).

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Psychomotor development is defined as physical activity associated with mental and psychological processes. Psychomotor activities involve actions and skills. Psychomotor activities are physical activities that involve mental and psychological processes. Psychomotor scope of physical activity and practical learning skills

(Khasanah & Darsinah, 2022). The psychomotor domain is a domain related to the nervous system and muscle function as well as some aspects of mental function (Hafizhah et al., 2022). From an early age, children accumulate experience and practice life skills to ensure future adaptation. Therefore, children need educational programs, care, and environments that can encourage their development and growth (Kamila & Hidayaturrochman, 2022).

Psychomotor assessment of students in blended learning must always be performed by teachers to determine student progress in learning engagement, so teachers can measure success immediately. even when there are students who do not do well in school and do not meet face to face. in managing their learning in the psychomotor domain and not just in the cognitive and affective domains (Sitepu et al., 2022). The psychomotor domain is the domain related to the ability or ability to act after a person performs a certain learning activity (Mudhakiyah et al., 2022).

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The PjBL model is a learning model that relies on students becoming comfortable with real-world problems that they find meaningful, determining how to represent them, and then working together to find solutions to them. those problems (Rachmantika et al., 2022). Applying the PjBL model in an online environment allows students to work independently on assigned learning projects. This learning requires students to be more active in collecting information from many different reference sources to facilitate the implementation of learning projects. In the PjBL learning model with an online environment, teachers play the role of monitoring students' learning activities through Google Classroom and WhatsApp. Google Classroom is used to share documents and assignments, collect assignments, and discuss the results of completed projects(Rachmantika et al., 2022).

Steps to learning the PjBL model in an online environment include identifying fundamental questions, developing a project plan, establishing a timeline, supporting students and project progress, evaluating results, and evaluating Online experience price using Google Classroom (GC). Student learning activities according to the PjBL model in the online environment. Students observe existing problems, students identify problems that arise in the group on WhatsApp, then a representative from the GC chat group responds to the discussion, students and their group plan for Project activities based on hypotheses, students in groups. By preparing the tools and materials that will be used in project activities, students and groups conduct projects and experiments to answer the questions posed. present the results of project activities and tests they took at GC and students work on assessment questions (Rachmantika et al., 2022). PjBL is an innovative education in which students are faced with increasingly difficult tasks. Difficult problems require in-depth research, more problem-focused action, multidisciplinary tasks, and ultimately a final product (Zega, 2022). Projects encourage students to gain meaningful learning experienc Some Islamic boarding schools have converted and adopted a more student-centered approach to education. They integrate religious curricula with general courses, develop more active and participatory teaching methods, and provide broader space for student creativity and exploration. born. Therefore, the reproduction of Santri must be massively accelerated and expanded, so that the viable option is not only their existence in the real world but also their birth in the virtual world, on the Internet or in the so-called " global village" (Musthofa et al., 2021). Follow teachings based on the teachings of Salafussalah scholars and use technological devices now available to the wider community If Al-Ishlah Islamic Boarding School helps the people of Temanggung then it is hoped that the digital Islamic boarding school program can meet society's broader need for knowledge Islamic religion (Musthofa et al., 2021). The form of information technology development using learning media is distance learning, online or online learning (Andika et al., 2020).

As time passes and educational requirements become more and more complex, some Islamic boarding schools have begun to update their teaching methods and be open to innovation and change. Therefore, although it can be observed that education in Islamic boarding schools has always been teacher-centered in some Muslim boarding schools, it cannot be claimed that this is a practice that applies universally to all Islamic boarding schools. Most learning models in Islamic boarding schools are not very advanced, specifically the traditional model. On the other hand, very few e-books also support learning in Islamic boarding schools (Ma'sum & Syafaat, 2015). Therefore, this is a challenge for technological development in virtual Islamic boarding schools. Project-based learning is a learning method that emphasizes active learning and hands-on experiences, where students gain skills and knowledge through projects or assignments related to realistic context. Project-based learning is great for developing students' psychomotor aspects, especially physical and motor skills.

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Students can develop physical and motor skills through project-based learning. Additionally, students can develop collaboration skills and other social skills that can help them in real life. The psychomotor domain is the domain related to the ability or capacity to act after a person performs a certain learning activity (Mudhakiyah et al., 2022).

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Characteristics of project-based teaching are; (1) Work is performed independently, from planning, preparation to product presentation; (2) The student takes full responsibility for the project created; (3) The project involves peers, teachers, parents and even the community; (4) Practice creative thinking skills; (5) The classroom situation is very tolerant of shortcomings and development of ideas (Satriani, 2022). When studying, teachers need to pay attention and make the best use of the time allocated for learning so that all learning can be done well (Perayani & Rasna, 2022).

Conclusion

The concept of implementing project-based learning is a learning method that emphasizes active learning and hands-on experiences, where students gain skills and knowledge through projects or assignments. related to the actual context. Project-based learning is great for developing students' psychomotor aspects, specifically physical and motor skills.

The teacher's role in the project-based learning (PjBL) strategy as an alternative in the field of psychomotor learning, especially in terms of fidelity, can be implemented through virtual learning. Virtual learning in Islamic boarding schools can also be used to develop the psychomotor domain. The learning plan of virtual teachers of Islamic boarding schools can be implemented to achieve the goal of learning performance.

The application of project-based learning can support the existence of virtual Islamic boarding schools. Virtual Islamic boarding schools are an alternative to traditional Islamic boarding schools, allowing students to study and interact online with teachers and other students. However, in virtual Islamic boarding schools, the challenge faced in developing the psychomotor domain of students is to limit the physical interaction between students and their environment.

Recommendations

This research is recommended for observing learning strategies, especially virtually. This research contains observations of strategies that can be used to develop the psychomotor domain in students. Virtual Islamic boarding schools play an important role in student development, so this research aims to find the right strategy for virtual-based learning.

Notes

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Using Art and Open Pedagogy in Mathematics Education

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Abstract: A new course development is intended for students to investigate the intersection of mathematics with seemingly disparate areas of art, music, architecture, and nature. The course is designed to allow students to explore the hidden connections between the aesthetic pleasures of art, music and nature and that of mathematical foundations and how the beauty of art, music and nature can be equated to the corresponding beauty of mathematics. Both art and mathematics require the ability to generate and recognize patterns and make use of spatial reasoning skills and this forms a natural connection between these seemingly distinct fields. Students often have negative attitudes towards learning mathematics and the word "mathematics" often has negative connotations for many students. To counteract these negative perceptions, the newly developed course provides hands-on experiments for students to investigate mathematical and artistic constructs -- students generate their own mathematical expressions through exploring art, music, and other genres by combining mathematical foundations with basic computing techniques. The design of the course emphasizes a synthesis of concepts from across art, music, architecture, nature, mathematics and computing to motivate students to explore linkages and connections between these subject areas from a new and innovative perspective. In addition, students create new knowledge or new connections regarding mathematics and other topics from the course that have not been previously documented. Students then publish their findings using Wikipedia pages in order to share their new knowledge.

Keywords: Mathematics, Art, Open Pedagogy

Introduction

Math educators often come across students expressing negative opinions and negative perceptions regarding mathematics education at the high school or college level. It is not unusual for a math educator to hear student opinions such as:

- "I was never good at math, and I will never be good at math, and I don't need math anyway"
- "Engineers and scientists need math, but I don't"
- "You are either a math person or not, and I am not"

- "Why should I be forced to take multiple math courses that have no use for me?"
- "I will never use this material again and so learning mathematics has no value for me".

Students often encounter these negative math related experiences early in their educational career, sometimes extending back to elementary school and students carry these negative perceptions with them throughout their educational career.

As one possible remedy to mitigate these negative attitudes towards mathematics courses, educators can consider exposing students to a different view of mathematics, namely the beauty of math, which is evident in diverse fields such as art, architecture, music, dance, nature, etc.

In this paper, I discuss a new course development which is intended for students to investigate the intersection of mathematics with these seemingly disparate areas of art, music, architecture, and nature. The course is designed to allow students to explore connections between mathematics and the pursuit of art, music and dance, and how these mathematical foundations can be equated to the corresponding beauty of mathematics.

In addition, the course offers students an opportunity to engage in open pedagogy where students generate new knowledge and new connections from their investigations and research and share this new knowledge through various forums.

Course Learning Objectives

The course is called "The Art of Mathematics" and is geared towards first- or second-year college students. There are no prerequisites and previous math experience is not necessary for the course. The course learning objectives are designed to allow students to form new connections through hands-on learning experiences and computing experiences. Course learning objectives include the following:

- Interpret, classify, and document examples of mathematical applications in various genres such as art, music, dance, and architecture.
- Identify and document applications of Fibonacci sequences in art, music and architecture, and relate these applications to the underlying mathematical pattern and symmetry of the Fibonacci numbers.
- Calculate the golden ratio and identify applications in art, music, and architecture. Summarize the relationship between the golden ratio and Fibonacci numbers.
- Investigate applications of geometry in art and architecture by exploring and creating tiles and tessellations and creating three-dimensional student expressions of mathematical art.
- Investigate and generate artistic patterns using lighting, computer programming, fractal mathematics and self-similarity aspects.
- Identify and discuss mathematical patterns and mathematical constructs in artistic renderings by renowned

artists such as DaVinci, Escher, and others

- Identify and demonstrate use of math constructs to render perspective drawings and artwork
- Contribute to the body of knowledge for mathematics and art by publishing updates to Wikipedia or similar content.

Course Design and Outline

Course activities and course assessments are designed to allow students to express their creativity and create art with mathematical connections. Course activities include various mathematical topics such as tessellations, Fibonacci sequence, golden rectangle, perspectives and symmetry, fractals and self-similarity, tiling, mathematics in music and dance, mathematics in architecture, mathematics in advertising and logo design, field trips to local museums, etc.

Students engage with artistic images that exhibit the beauty, symmetry, and elegance of mathematics (Ornes, 2018). A number of guest speakers visit the class throughout the course to bring in outside perspectives and expertise on a number of topics such as mathematics and music, as well as mathematics and graphic design. Elements.

The course makes use of open educational resources including a collection of works called "Discovering the Art of Mathematics" (Fleron 2012). This site provides a collection of mathematical resources and links to supplementary books on dance, music, patterns, and more.

Students also engage in a final capstone program to synthesize various topics from the course and extend the topic to research new connections and new knowledge. Students then present this in a final presentation and also publish this information as an update to a Wikipedia page on a relevant topic.

For this final course project: Students select a topic from the course with the goal of investigating and researching new knowledge and new connections. When selecting a topic from the course to be researched, students seek out a math concept discussed in the course, which overlaps with their own personal interest and personal connections.

Students follow this general outline to complete the final project.

1. Conduct independent research using PSU Library databases and resources.
2. Discuss the connection between mathematics and selected topic.
3. Discuss personal connections to the topic.
4. Discuss new knowledge or new connections not previously documented.
5. Present findings to the class during the last week of the semester.

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This final project then forms the basis for a Wikipedia related project where students publish this new information and new knowledge as an update to an existing Wikipedia page (or students can create a new Wikipedia page as well).

In creating and sharing this new knowledge, students engage in open pedagogy which leads to the following course objectives:

- Apply strategies of open pedagogy in course development where students generate their own new knowledge to add to the existing database of knowledge on a certain topic.
- Understand how to incorporate student Wikipedia authorship as part of open pedagogy and weave this authorship as part of course objectives and course assessments and recognize how knowledge is negotiated by Wikipedia authors.
- Understand open pedagogy as an educational and instructional practice of active learning to motivate and engage students and convert a course from teacher-centric to learner-centric

Results

Students have a very positive response to the course and towards the end of the course, students indicate that they have a new appreciation for the role of mathematics in diverse fields such as art, music, dance, nature, etc. Students also express a desire to engage in deeper mathematical discussions related to topics of interest to students. For example, students with musical backgrounds are often interested in exploring more about the connections between mathematics and music. Students with engineering backgrounds are often interested in learning more about topics such as golden rectangles and fractal analysis. Students with interests in the medical field are interested in learning more about the role of mathematics in medical applications.

This change in perceptions about mathematical utility and application serves to counteract the negative perceptions and attitudes students typically have regarding mathematical study, especially at the college level.

Provided below are some examples of student final projects where students extended their knowledge and formed new connections to mathematical concepts:

- Works of artist Antony Gormley, connection to Golden Ratio.
- Finding beauty in chaos – programming new fractals.
- Mathematical aspects of cinematography by Anthony Kubrick.
- Mathematical aspects of Islamic Calligraphy.
- Chaos Music Theory and relationship to dementia.
- Artistic creations using mathematical forms and welding.
- Connections between design of Il Duomo and Fibonacci numbers.

- Mathematics and connections to Mozart and Beethoven.
- Mathematical connections of waves and implications for surfers.
- Mathematics and connections to Sacred Geometry.

Discussion

While mathematics and art are sometimes considered as disparate subjects, there are actually many connections and relationships between the two fields. Connecting the two fields together can actually make mathematics more approachable and less intimidating for students (Exploring the Connection Between Math and the Arts. (2021, Apr 23).

By connecting mathematics and other seemingly distinct subject areas, not only do students gain a new perspective on mathematical foundations and mathematical connections to various fields, but students also benefit in a number of other ways as well from their open pedagogy initiatives:

- Allows students to take ownership of a topic of interest from the course and research and explore to investigate new connections.
- Students sometimes identify connections between two seemingly disparate concepts from the course.
- Students are introduced to research methods and procedures.
- Students engage with peers during presentations to ask probing questions and enhance content to publish to Wikipedia.
- Students enhance their writing skills as they draft updates to Wikipedia pages.
- Students explore open pedagogy and generate new knowledge and new connections.

Conclusion

A new college level course has been developed called "The Art of Mathematics" that seeks to address negative student perceptions about mathematics education. The course emphasizes the beauty of mathematics and connections with other fields such as art, music, dance and nature.

The course has been designed to allow students to explore the hidden connections between the aesthetic pleasures of art, music philosophy and that of mathematical foundations and how the beauty of art, music and nature can be equated to the corresponding beauty of mathematics.

Both art and mathematics require the ability to generate and recognize patterns and make use of spatial reasoning skills and this forms a natural connection between these seemingly distinct fields.

The course provides hands-on experience for students to investigate mathematical and artistic constructs -- students will be asked to generate their own mathematical expressions through exploring art, music, and other genres by combining mathematical foundations with basic computing techniques.

The course emphasizes a merging of concepts from across art, music, architecture, nature and mathematics to motivate students to explore connections between these subject areas from a new and innovative perspective. The course ends with a capstone project involving open pedagogy where students seek out new knowledge and new connections and publish their findings as an update to a related Wikipedia page.

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Predictive Power of Social Determinants on Access to Medical Care Among Individuals with Diabetes in the United States

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Abstract: Diabetes remains a significant public health challenge in the United States, placing a substantial burden on individuals and the healthcare system. Ensuring access to medical care is critical in diabetes care. Using Micro data records from the Demographic Health Survey in the Integrated Public Use Microdata Series (IPUMS), the study examined the predictive power of social determinants on access to medical care among 2,620 individuals with diabetes in the United States. Delaying seeking medical care because of worry about the cost served as the response variable. The predictor variables were type of diabetes, sex, age, region of residence, and employment status. A combination of Upsampling and Binary Logistic Regression analyses showed that sex, age, and region were significant predictors of individuals with diabetes delaying seeking medical care due to cost. Female patients had higher odds of delaying seeking medical care than their male counterparts. There was decreasing odds of delaying seeking medical care as age increased. Types of diabetes and employment status were not statistically significant predictors at the 0.05 level.

Keywords: Diabetes, Up-sampling, Binary Logistic Regression

Introduction

Diabetes remains a significant public health challenge in the United States, placing a substantial burden on individuals and the healthcare system. Ensuring access to medical care is critical in diabetes care. About 10.5% of the population, have diabetes (CDC, 2021). The economic impact is equally daunting, with diabetes and its related complications accounting for billions in healthcare costs annually (American Diabetes Association,

2020). Diabetes is a major cause of health conditions such as blindness, kidney failure, heart attack, and stroke and the seventh leading cause of death in the United States in 2020 (WHO, 2021). Social determinants such as income and education level have been shown to significantly affect the prevalence and management of diabetes, with lower socioeconomic status linked to higher disease incidence and poorer health outcomes (Schillinger, 2020).

Access to medical care is key to effective diabetes management. However, individuals from low socioeconomic backgrounds often encounter barriers to receiving proper care due to the lack of insurance and health literacy (Karagiannis et al., 2023). Research has consistently shown that improved access to healthcare services leads to better diabetes management and reduced complications (Norris et al., 2002). Also, low literacy is associated with less diabetes-related knowledge which may be related to other key health outcomes (Bailey et al., 2014).

Purpose of the Study

The study examined the predictive power of social determinants on access to medical care among 2,620 individuals with diabetes in the United States. Understanding the predictive power of social determinants on access to medical care for individuals with diabetes is crucial for developing targeted interventions and policies.

Research Questions

The following research questions underpinned the study:
1. To what extent do individuals with diabetes delay seeking medical care due to cost?
2. How do demographic factors predict individuals with diabetes delaying seeking medical care due to cost?
3. How does geographic location predict individuals with diabetes delaying seeking medical care due to cost?
4. How does socioeconomic status predict individuals with diabetes delaying seeking medical care due to cost?

Method

Participants

The studied participants included 2,620 individuals diagnosed with diabetes in the United States. These participants were arrived at after series of data cleaning and preprocessing.

Data

The data for this study were sourced from microdata records provided by the Demographic Health Survey, which is part of the Integrated Public Use Microdata Series (IPUMS). The IPUMS is a comprehensive database that includes a variety of demographic and health-related information collected through national surveys.

Variables

The primary outcome of interest (response variable) was whether participants delayed seeking medical care due to worry about cost. This variable was binary, with responses categorized as either "Yes" (indicating a delay in seeking medical care) or "No" (indicating no delay). The following variables were examined as potential predictors of delaying medical care:

- Type of Diabetes (DIABTYPE): Classified into Type 1 or Type 2 diabetes.
- Sex (SEX): Coded as male or female.
- Age (AGE): Measured as a continuous variable.
- Region of Residence (REGION): Defined by geographical areas within the United States.
- Employment Status (EMPSTAT): Categorized as employed or unemployed.

Statistical Analysis

Descriptive statistics, including frequencies, percentages, and quartiles, were calculated to provide an overview of the demographic and health characteristics of the studied participants. This initial analysis helped to identify general trends and distributions within the data.

Several inferential statistical tests were conducted to investigate the associations between the predictor variables and the response variable. The Pearson's Chi-Squared Test was used to evaluate the association between categorical variables, such as sex and type of diabetes, with the response variable. The Wilcoxon Rank Sum Test was applied to compare the distribution of age between those who delayed seeking medical care and those who did not, providing a non-parametric alternative to the t-test for comparing two independent samples.

Finally, the Binary Logistic Regression with Up-sampling was performed to model the probability of delaying medical care based on the predictor variables. Given the potential imbalance in the response variable (i.e., fewer individuals delaying care compared to those not delaying), up-sampling was employed to balance the class distribution. Up-sampling (Chawla et al. (2002) involves replicating the minority class to achieve a more balanced dataset, thereby improving the model's predictive performance. All significance tests were conducted at a 0.05 level of significance, ensuring that results were statistically robust and minimizing the likelihood of Type I errors.

Results

Individuals with Diabetes Delay Seeking Medical Care due to Cost

Table 1 shows summary statistics for individuals with diabetes delay seeking medical care due to cost. From the table, approximately 6% delayed seeking medical care. SEX and EMPSTAT were found to be associated with

delaying seeking medical care. In addition, there was a significant difference in AGE with delaying seeking medical care. Furthermore, DIABTYPE and REGION were not associated with delaying seeking medical care.

Table 1. Summary Statistics

Variable	N	**1**, N = 2,459[1]	**2**, N = 161[1]	**p-value**[2]
DIABTYPE	2,620			0.8
Type 1		216 (8.8%)	13 (8.1%)	
Type 2		2,243 (91%)	148 (92%)	
SEX	2,620			0.020
Male		1,194 (49%)	63 (39%)	
Female		1,265 (51%)	98 (61%)	
AGE	2,620	66 (58, 75)	57 (49, 64)	<0.001
REGION	2,620			0.5
Northeast		372 (15%)	24 (15%)	
North Central/Midwest		559 (23%)	29 (18%)	
South		1,033 (42%)	75 (47%)	
West		495 (20%)	33 (20%)	
EMPSTAT	2,620			<0.001
Not Employed		1,617 (66%)	77 (48%)	
Employed		842 (34%)	84 (52%)	

[1] n (%); Median (IQR)

[2] Pearson's Chi-squared test; Wilcoxon rank sum test

Social Determinants of Individuals with Diabetes Delay Seeking Medical Care due to Cost

Table 2 displays binary logistic regression analysis with up-sampling of individuals with diabetes delay seeking

medical care due to cost. The data show that the odds for Females delaying seeking medical care was about 51% higher than the odds for Males. Also, as AGE increases by a year, it was expected that the odds of delaying seeking medical care due to cost decreases by about 4%. Finally, DIABTYPE, REGION, and EMPSTAT were not significant predictors of delaying seeking medical care due to cost.

Table 2. Binary Logistic Regression Analysis with Up-sampling

Characteristic	OR[1]	95% CI[1]	p-value
(Intercept)	0.443	0.151, 1.236	0.128
DIABTYPE			
Type 1	—	—	
Type 2	1.739	0.977, 3.355	0.077
SEX			
Male	—	—	
Female	1.512	1.087, 2.119	0.015
AGE	0.956	0.944, 0.969	0.000
REGION			
Northeast	—	—	
North Central/Midwest	0.762	0.433, 1.352	0.348
South	1.084	0.677, 1.791	0.745
West	0.983	0.568, 1.725	0.952
EMPSTAT			
Unemployed	—	—	
Employed	1.227	0.849, 1.774	0.276

[1] OR = Odds Ratio, CI = Confidence Interval

Conclusion

Most (94%) of the respondents did not indicate delay in seeking medical care due to worry about cost. SEX and AGE were significant predictors of delaying seeking medical care due to worry about cost. However, DIABTYPE and REGION were not associated with delaying seeking medical care. In terms of the predictive power of social determinants on access to medical care among individuals with Diabetes in the US, Sex and AGE were key predictors.

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Psychology's Grand Experiment: In Search of a Cumulative Science

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Abstract: As the acclaimed science of behavior and mental processes, psychology has evolved from its philosophical roots into a discipline of diverse perspectives and approaches. Textbooks in psychology identify the scientific method as the glue that holds psychology together as a unified discipline. Psychology appears to be unique among the sciences in having developed two parallel research traditions due to historical philosophical divergences that have inevitably established psychology's grand experiment. The experiment was a methodological assessment of the relative efficacy of the two traditions in supporting the cumulative character of sciences. Psychology's history reveals that much experimentation relied on small-N designs despite significant differences in focus on behavior vs. mental processes. The introduction of inferential statistics changed that, marking the beginning of the growth of large-N group designs and coinciding with a rise in focus on the mental. The ongoing crises of confidence in psychology have had exaggerated expressions in mainstream psychology compared to behavioral psychology, the one heavily vested in large-N group designs mostly driven by null hypothesis statistical testing (NHST) and the other in small-N designs. To embrace a future that is focused on achieving a cumulative science, psychology needs to rethink and overhaul its almost exclusive reliance on hypothetical constructs and redirect attention to the study of processes, behavioral or mental. Doing so requires abandonment of arbitrarily adopting large-N group designs by default as is commonly taught in mainstream psychology. Choice of methods would be determined by the nature of the research question, not by statistical considerations, as illustrated.

Keywords: Psychology, Methodology, Statistical Significance Testing, Pedagogy, Cumulative Science

Introduction

Today, many introductory psychology textbooks define psychology as the scientific study of behavior and mental processes (e.g., Bernstein, Penner, Clarke-Stewart & Roy, 2007; Myers & Dewall, 2017). Historians of psychology (Leahey, 2000; Wertheimer, 2000) pin its founding to the establishment of the first psychological laboratory in Leipzig, Germany in 1879 by W. Wundt. Since its founding, psychology has developed into a discipline of very diverse perspectives and approaches, from psychophysics to psychopathology, from

personality to perception and social psychology, to name only a few. Introductory psychology textbooks often identify the scientific method as the glue that holds psychology together as a discipline (see e.g., Berstein et al., 2007). Yet, it has remained methodologically divided over the decades. Perhaps unlike any other discipline, psychology has evolved two parallel methodologies, namely, in current parlance, the large-*N* group designs and small-*N* individual designs. Although contemporary mainstream psychology may appear to use only large-*N* group designs, the two methodologies have coexisted for decades, albeit largely in parallel.

According to Imam and Frate (2019),

> The two [methodological] approaches differ in very important ways and by tradition. One of the major differences is the heavy reliance on inferential statistics in the group designs than in snall-*N* designs. Another important difference is on the built-in emphasis on replication and reproducibility of effects in the small-*N* designs than in the large-*N* group designs. These particular differences suggest a diametrically opposed impact of the methodology crisis in the different specializations within psychology that tend to adopt them, namely, group designs in cognitive and small-*N* designs in behavioral psychology. One could say without prejudice that what the one is doing or experiencing because of the crisis is of no concern to the other, because of the apparent gulf between the two approaches in psychology.... The question is: if research method has been and continues to be the unifying force that binds psychology together as a science, can we afford to remain dispassionately indifferent to what goes on in the different domains of psychology? (p. 205).

The short answer is, no!

Despite the current apparent preeminence of large-*N* group designs, the history of psychology reveals that small-*N* research was prevalent in psychological research before the incorporation of statistical methods (Boring, 1961) into large-*N* designs that then remained alongside them. The major purpose of this paper is to show that the two methods, first the one alone and then the two together, invariably established psychology's grand experiment. The impetus for the grand experiment is that it affords a methodological assessment of the relative efficacy of the two methods in supporting the cumulative character of science in psychology. The opening section presents the historical and empirical evidence for two parallel research traditions and how they define psychology's grand experiment, concluding with the research cycles and characterization of the two methodologies.

A History of Two Methodologies and the Grand Experiment

During its earliest historical periods, despite important differences in the focus on behavior vs. mind (today's mental processes), most experiments in psychology studied small numbers of subjects. In other words, contemporary divides such as between cognitive and behavioral psychology did not reflect the choice of number of subjects studied; whether interest was in behavior or the mind, there appeared to be agreement on studying small numbers of subjects. There are several lines of evidence for the prevalence of use of small numbers of subjects in psychological research in the early years of psychological science. The following subsections

describe the respective evidence that collectively define psychology's grand experiment.

Early Prevalence of Small-N and (No Inferential) Large-N Research

First, I examined experimental psychology articles appearing in *American Journal of Psychology* (*AJP*) from 1900 (well after the founding years) to 1950 for evidence of the type of research that was prevalent in those early years of psychological research. *AJP* is of interest as one of the journals previously cited for publishing *N* = 1 studies (Dukes, 1965) discussed below; the interest was in how far back in the history of the journal was the practice of using small numbers of subjects. Figure 1 presents separately the data for empirical articles reporting only one experiment (left panel), those reporting two experiments (top right panel), and those reporting more than 100 subjects (bottom right panel).

Pub Year	Number of Subjects
1900	2
1911	4
1911	6
1913	14
1913	4
1915	2
1920	6
1921	4
1923	4
1923	5
1924	2
1924	11
1925	12
1926	4
1927	3
1927	2
1927	24
1929	3
1930	6
1931	4
1931	10
1932	7
1933	19
1933	5
1934	49
1934	50
1934	2
1934	100
1934	73
1937	7
1938	23
1940	5
1943	100
1944	40
1945	9
1945	28
1946	9
1947	4
1947	5
1947	72
1948	59
1950	20

>1 experiments

Pub Year	Number of Subjects
1903	1,1
1916	4, 5
1925	5, 100
1928	7, 100
1932	4, 8
1936	10, 10, 11
1937	200, 11
1940	4, 3, 4, 3
1941	12, 30
1946	8, 8

Ss > 100

Pub Year	Number of Subjects
1930	125
1932	324
1936	103
1937	142
1937	200, 11
1948	569

Figure 1. Number of subjects reported in experimental psychology articles appearing in *American Journal of Psychology* (1900-1950)

First, the data on the left represent number of subjects in each article from various publication years, showing that most articles reported very few numbers of subjects throughout the period and only in later years do we see

large numbers from about 50 to 100, specifically in only 7 (12%) articles. Second, the top right data are from a set of articles that reported more than one experiment showing that 1) some of them used small numbers in all experiments (12%) and 2) some of them used small numbers in one experiment and large numbers in another (5.3%; as in the 1925, 1928 and 1937 articles). The Guilford and Dellenbach (1925) and Oberly (1928) studies of memory processes highlighted in the figure worked with small (5, 7 Ss respectively) and large numbers of subjects (100 Ss each). Guilford and Dallenbach described the experiments with small numbers as "intensive" studies and those with large numbers as "extensive" studies (see Figure 2). Finally, the bottom right data show only six articles (10.5%) reported using more than 100 subjects.
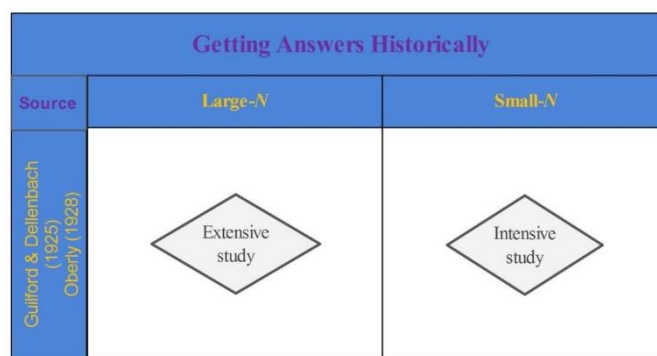
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Figure 2. Pre-inferential statistics large-*N* (extensive) and small-*N* (intensive) research on memory processes

We should note that as was common then, neither the Guilford and Dellenbach (1925) study nor the Oberly (1928) study resorted to statistical inference to interpret their results as is the practice today, despite using large numbers of subjects. How then did inferential statistical practices enter psychological research? For this, we turn to the second line of evidence provided by Hubbard and Ryan (2000).

Introduction of Statistical Significance Testing in Large-N Research

Hubbard and Ryan's (2000) study surveyed other psychology journals, beginning from the 1890s, on the rise of statistical significance testing. For better appreciation of the import of the entry of inferential statistics into psychological research, however, it is worthwhile to consider very briefly first the historical background of their use in psychology. In the 1930s and early 1940s, according to Schneider (2015), textbooks in statistics and research design combined two different and controversial approaches to statistical inference, despite very important differences between the two approaches, into the hybrid we recognize today as null hypothesis statistical testing (NHST; see Imam, 2021 for a fuller treatment). Contemporary psychological research heavily relies on NHST for data analysis and interpretation and, therefore, is a focal issue for the purpose of the present analysis. Indeed, Imam has argued that the point of separation between behavioral psychology and most of the rest of psychology (see Smith & Little, 2018) methodologically was "the actual coupling of psychological research and statistical inference" (2022, p. 284; see Cowles, 2001; Stigler, 1992). Cowles's historical account

appears to support the notion that the wholesale adoption of statistical significance testing in the form of NHST, in contradistinction to experimental control, carries with it "dangers" for the psychologist in downplaying its "limitations" (2001, pp.19-20), as we shall see in what follows.

To return to the Hubbard and Ryan (2000) study, they examined 12 APA journals, ranging from clinical, educational, experimental, to (the last 3) general review journals. Imam (2021) described the detailed yearly reporting of the three statistics that were in use during the coverage period, including probable errors (pe), critical ratios (cr), and the *p*-value. The results showed that 1) beginning in the 1910s, only pe and cr were reported for inference; 2) during the immediate period of the aforementioned hybridization that occurred in the 1930s and 1940s, *p*-value reporting gradually appeared; 3) not long after, *p*-value reporting rose almost to the level of the other two statistics combined; and 4) by the mid-1950s, the other two statistics literally disappeared, as *p*-value reporting began its asymptote. Figure 3 presents the significance testing timeline from the Hubbard and Ryan data. The figure shows that the earliest years (1894-1909) of psychological research in the cited APA journals did

Figure 3. statistical significance testing timeline from Hubbard & Ryan (2000) data

not involve any reporting of statistical significance testing. There were 28 empiral articles during this period. Of the 320 empirical articles counted in the next period (1910-1929), only 53 reported cr and pe. The number of empirical articles increased substantially in the next decades (1930-1964), marked by not only the introduction of *p*-value reporting but also its overwhelming adoption quickly surpassing the other two statistics, with 86% of the articles reporting *p*-values. By the mid-1960s and beyond, no empirical articles reported the pe and cr anymore; they all (100%) reported *p*-values. With the advent of the supremacy of NHST in psychological research, which marked the demise of cr and pe statistics from inference, what became of studies with small numbers of subjects in psychology? For answers we turn, finally, to the third line of evidence provided in Duke's (1965) $N = 1$ paper.

The Coexistence of Two Traditions in Psychological Research: Dukes' (1965) N = 1 paper

Dukes' (1965) paper represented the case for the coexistence of two traditions of $N = 1$ research and large-N group designs in psychology in the context of the apparent predominance of the latter approach in mainstream psychology. He provided examples of multiple studies from diverse journals that employed the former approach over various periods in the history of psychology. The examples included Ebbinghaus' study of memory in 1885, Breuer's case of Anna O in 1895, Stratton's inverted vision in 1897, Bryan & Harter's (1899) learning plateaus, Prince's multiple personality in Miss Beauchamp in 1905, Cannon & Washburn's kymographic hunger pangs study in 1912, Watson & Rayner's little Albert study in 1920, Jone's little Peter study in 1924, and The Kellogs' chimp project with Gua in 1933. Additional $N = 1$ studies appeared in psychology journals Dukes cited after 1934, ranging from *Journal of Experimental Psychology*, *Journal of Educational Psychology*, to *Journal of Social Psychology*. Notably, as Imam (2021) pointed out, Dukes list did not include the *Journal of the Experimental Analysis of Behavior*, the premier journal of behavioral psychology and home of small-N designs in psychological science, suggesting that $N = 1$ research was not a phenomenon limited to the Experimental Analysis of Behavior. Furthermore, the period of 1934 and 1965 when these journals reportedly published $N = 1$ studies covered the publication of B. F. Skinner's (1935) The *Behavior of Organisms* and Sidman's (1960) *Tactics of Scientific Research*, both being important publications in behavioral psychology, one empirical, the other a methodology text.

Being cognizant of the context of widespread use of group designs and NHST, a couple of observations by Dukes (1965) bear on the coexistence of the two research method traditions in psychological research. First, according to Dukes, "the absolute number is noteworthy and is sizable enough to discount any notion that $N = 1$ studies are a phenomenon of the past," and second, "according to subject matter, they are seen to coextend fairly well with the range of topics in general psychology" (1965, p. 76). The latter observation is consistent with the claim above that the use $N = 1$ research was not limited to behavioral psychology during the period of NHST dominance in psychological research.

Indeed, it is not as if during the period of pervasive NHST use, there were no important work done without significance testing. In fact, Gigerenzer and Marewski (2015) identified significant psychological discoveries that did not involve the use of significance testing at all. Classic discoveries in psychology that did *not* report *t*-tests, *p*-values, confidence intervals, or Bayes factors included Jean Piaget's development stages, Wolfgang Köhler's Gestalt laws of perception, Ivan P. Pavlov's principles of classical conditioning, B. F. Skinner's principles of operant conditioning, George Miller's magical number seven plus minus two, and Herbert A. Simon's Nobel Prize–winning work in economics.

In summary then, the history of psychology invariably established a grand experiment in which two methodological approaches emerged first with small numbers of subjects at its inception and then the introduction of statistical significance testing with large-N group designs that has coexisted with the small-N approach for decades. The history reveals that what is problematic for psychological science, therefore, is not

the use of large numbers of subjects per se, but the linking of their use to statistical significance testing in the form of NHST. What has happened in those decades in terms of the relative effectiveness of the two approaches is the focus of the next section.

Research Cycle in Large-N Group Designs and Small-N Individual Designs

Before delving into the outcomes of the two approaches in psychological research, it is illuminating to consider how the two operate. The predominant large-*N* approach, of the 2 methodological traditions in psychology, has become inexorably tied to inferential statistics today, mostly in the form of NHST. Two additional inferential approaches that are considerably less common are the estimation (Cumming, 2014) and Bayesian (Kruschke & Liddell, 2018) approaches. Indeed, Imam (2022) showed that textbooks in psychology and education rarely, if at all, cover these other inferential approaches. The virtual neglect of Bayesian inferential statistics pedagogically and in research practices is the focus of further discussion below.

In a nutshell, the research cycle in group designs typically begins with the development of a hypothesis or hypotheses (hopefully theory-informed), followed by the adoption of a research design (typically using experimental and control groups) that is heavily informed by statistical considerations, before research participants are recruited (usually from college-students research pools). The study then is conducted collecting data that are later aggregated and then analyzed, mostly using NHST. The findings then are reported in conferences and/or in publications. Building theory is rarely the focus, but the literature "grows" nonetheless, generating more hypotheses. As noted, the design choice often is informed by significance testing considerations but even these are rarely satisfied in practice. For example, from the outset, basic statistical assumptions and requirements such as specifying alpha and/or *p*-value, specifying the relevant population (for estimating parameters), or ensuring the population meets normality requirements, among others, rarely are done, checked, or known. Furthermore, requisite power analysis often is ignored (see Szucs & Ioannidis, 2017), not to mention the violation of the random sampling requirement by default reliance on convenient samples largely. Even the random assignment of participants to various groups of the experiment is sometimes flimsy. Perhaps one of the most troubling aspects of the impact of NHST in mainstream psychology is the misconception of the *p*-value as indicative of the probability to replicate a study (Lambdin, 2012).

In contrast, in contemporary small-*N* designs, the focus is usually solely on the individual, situation, or setting (mostly the individual), only a few subjects are studied at a time, each subject being exposed extensively to various conditions of the relevant variables and each exposure to the variables lasting until the measurement demonstrates stability. Each subject serves as his or her own control, experiencing all conditions of the experiment. The analysis and reporting usually focus on revealed functional relationships between behavior and environmental conditions, emphasizing behavioral processes throughout. Moreover, they are known for their reputations in "precise measurement, experimental control, and quantitatively exact theory" (Smith & Little, 2018, p. 2084). Furthermore, replication is so entrenched that it takes three different forms, namely, data

consistency within conditions, reproducible effects across conditions, and reproducible effects across subjects or situations (see Imam, 2021). A failure to replicate in small-*N* research (e.g., Silbaugh & Swinnea, 2018) does not amount to another straw on the camel's back as often is the case with group designs, but rather presents an opportunity to refocus on the search for controlling variables via experimental control, not statistical ones as commonly sought in mainstream psychology.

In the next section, presenting the outcomes of the grand experiment outlines the respective performance of the two research traditions and then highlights a couple of notable ideas amidst the myriads of solutions on offer for problems emanating from overwhelming adoption of NHST with large-*N* group designs.

Assessing the Results of the Grand Experiment

Adverse Consequences of Widespread NHST Adoption in Large-N Group Designs

Unfortunately, there are multiple disadvantages for psychological science from the widespread adoption of some of the statistical significance testing methods, particularly, NHST. Over the years, the problems have been compounded by the ritualization of its use (see Imam, 2021) across a wide swipe of the discipline, with only few exceptions in psychophysics, vision research, and behavioral psychology (see Little & Smith, 2018). Imam (2022) contrasted the relative impact of the overreliance on NHST in large-*N* vs. small-*N* designs, including the pervasive presence of *p*-hacking and replication failures, and the lack of representativeness and cumulative characters of psychological science in the former in contrast to the latter. Of these disadvantages manifested by the widespread group design usage, the failures to replicate important psychological findings exposed the weaknesses of the part of the discipline most associated with the practice in terms of its credibility and its capacity to build a cumulative science. In other words, the key outcome of psychology's grand experiment has been the predictable unworkability of the marriage of large-*N* studies with statistical significance testing that began in the mid-1930s described above.

The myriads of problems that ensued due to the ritualized use of NHST in mainstream psychology were unavoidable and intractable. Multiple statistical assumptions in psychological research are violated routinely (Erceg-Hurn & Mirosevich, 2008). One questionable research practice (QRP) begot another and all became routine. For example, incentivized pursuit of the "sexy," such as happened in the power posing saga (Whitt et al., 2022), encouraged *p*-hacking, a practice that invariably builds a literature wrought with publication bias. Heavy reliance on college students from mostly western origins (Henrich et al., 2010; Krypotpos et al., 2022; e.g., Muthukrishna et al., 2020) for samples have raised questions of representativeness and generalizability of psychological phenomena. The charge of underpowered research while using group designs in psychology premised on the statistical requirement for large numbers (see Little & Smith, 2018; Smith & Little, 2018) often suggest use of power analysis (e.g., Wilson et al., 2022), which invariably also contributes to publication bias to the extent that sufficiently high power produces lower *p*-values and hence significant findings (Krypotos et al., 2022; Wagenmakers, 2007) that then got published. All of these are antithetical to the goal of building a

cumulative science. The parts of the discipline in mainstream psychology (Little & Smith, 2018; cf. Stevens, 2017) and in behavioral psychology that maintained the reliance on small numbers of subjects in studying psychological phenomena have not experienced similar adverse fates. In other words, psychology's grand experiment has revealed crises of confidence in mainstream psychology that adopted ritualized NHST usage with large-N research methods, in contrast to behavioral and other areas of psychology that kept small-N research methods. The crises in the former are not generalizable to the latter. According to Little and Smith, "[t]he fact that areas that routinely use small-N paradigms have so far remained immune to the replication crisis afflicting other areas of psychology can be seen as an object lesson on the kind of methodological reform that the discipline requires, which goes deeper than just the routine practice of replication" (2018, p. 31).

Many solutions have been put forward to address many of these problems engendered by the use of NHST in psychological research. Most of them, if not all, have been based one way or another on statistical (see Grice et al., 2017; Oberauer & Lewandowsky, 2019; Smith & Little, 2018) or what I call scientosocial (see Grice et al., 2017; Oberauer & Lewandowsky, 2019; Stevens, 2017) remedies, not experimental ones. Amidst all the "noise," one can see some discernible hints in the iceberg that suggest deeper solutions to psychology's mainstream methodological problems. First, the use of large-N and small-N designs served different purposes historically. What about now? Second, the relative neglect of Bayesian approaches to inferential statistics may well be a function of a poorer understanding among most psychological researchers of how that approach does inference.

A Couple of Observations from the Haystack of Current "Solutions"

Why Large-N or Small-N? The history of large-N and small-N studies side by side (e.g., Guilford & Dallenbach, 1925; Oberly, 1928) before the introduction of inferential statistics suggests that they served different purposes for the researchers. Guilford and Dallenbach, for example, appeared to use one as a check on the other in the way they presented their results (see p. 627). Similarly, Oberly stated: "In order to obtain further information regarding the two methods [of memory tests], a group experiment was conducted with 100 Ss" (1928, p. 299). In current situations, even with inferential statistics, what sort of status could large-N studies appropriately be assigned? The dual-purpose utility of inferential statistics, namely, "estimating population values (parameters) from …the sample statistics" on the one hand, and "hypothesis testing, the process of judging whether or not a particular statistical outcome is likely or unlikely to be due to chance" (Cowles, 2001, p.7) on the other hand, often is confused or underappreciated (see Colling & Szucs, 2021). Wagenmakers et al. (2018) make similar points about the Bayesian approach.

In what appears to be a throwback to those golden days of psychological research, Smith and Little (2018) advocated optional adoption of large-N and small-N designs determined by the target purpose of the research (see Figure 3), taking account of the parameter estimation function of inferential statistics. The idea, simply, is to consider what the objective of the research exercise is. If interest is the "estimate of population parameters,"

then using group designs with "increase [in] sample size at the participant level is an appropriate one" (p. 2097; see also Grice et al., 2017). Otherwise, "[i]n environments that can be explored at the individual level and the phenomenon of interest is expressed as an individual mechanism, small-*N* studies have enormous inferential power and are preferable to group-level inference precisely because they place the burden of sampling at the appropriate level, that of the individual" (p. 2097). In a similar vein, Normand (2016) argued that 1) adopting large number per se only yields "knowing very little about very many," and 2) "repeated measures of an individual's performance should constitute the relevant "population"—a population of representative individual performance measures" (p. 1).

Figure 3. Distinguishing large-*N* group designs and small-*N* individual designs based on the goals of research

Which Statistical Significance Test? The apparent neglect of Bayesian inferential statistics for NHST even in research method textbooks in psychology and education (see Imam, 2023) indicates a misconception of their respective mode of operation in inference. Current solutions for the crises of confidence in psychology have focused almost exclusively on "fixing" the methodology as presented by the use and reliance on NHST. Only tangentially are alternatives like Bayesian inference being incorporated in mainstream psychological research. Efforts to educate on how to use it (Kruschke & Liddell, 2018; Wagenmakers et al., 2018b; Wei et al., 2022) may begin to make a dent in research practice going forward. So far, however, mainstream neglect of Bayesian approach in psychology appears to be the order of the day (see Jevremov & Pajic, 2024; Wagenmakers et al., 2018a). According to Jevremov and Pajic, "despite the obvious rise of the interest in Bayesian method in psychology, the research suggests that share of Bayesian-related articles in the total number of articles is still very small" (2024, p. 8653).

Colling and Szucs (2021) advocate the adoption of both NHST and Bayesian approaches to inference as a matter of choosing the "right tool for the right job in a complete system of *scientific inference*" (p. 142) in lieu of a solution. Their argument is that NHST is more suited to "exploratory research" in which interest is in determining magnitude or range of a measurement, for example, and Bayesian statistics are more suited to theory testing, because they "thrive in situations involving model comparison [and] parameter estimation" (p.

143; see also Szucs & Ioannidis, 2017b). This contrast between exploratory research and theory testing suggests that the sense of "exploratory" research here is not to be confused with Wagenmakers et al.'s (2012; see also Rubin & Donkin, 2022) usage, which describes post-hoc analyses and maneuvering that has characterized much of ritualized (Davidson, 2018) psychological research. Admittedly, NHST is inadequate for theory testing or evaluation of theoretical models (Grice et al., 2017). According to Grice et al., "[u]sing NHST as the sole arbiter of whether a finding has been replicated (or not), ignores the fact that the magnitude of effect being addressed may not be theoretically or practically meaningful," especially in regard to reliance on aggregates when " individual-level assessment" is required (2017, p. 63).
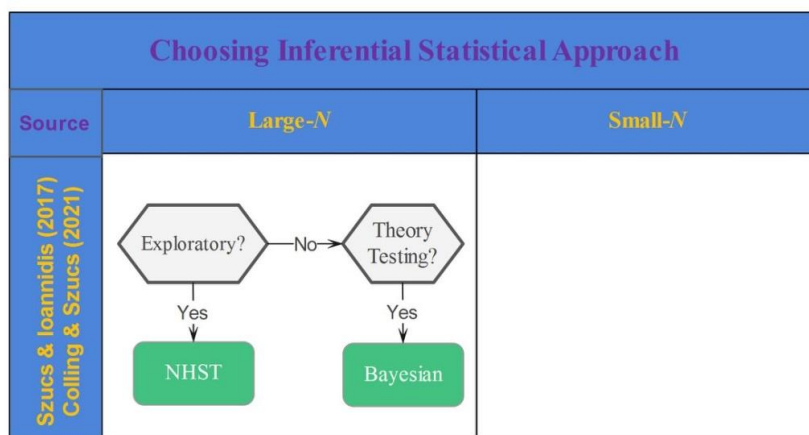
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Figure 4. Choosing statistical significance testing method in large-N research using group designs based on the nature of the research aim

The insights provided by these couple of positions amidst the array of reforms on offer for dealing with the replication crisis in psychology provide a window into a way forward in seeking a psychology more amenable to the objective of attaining a cumulative psychological science. İf one were to characterize the earliest phase of research in psychology in which small-N and large-N without statistical signifcance testing as baseline (Phase A), and the later phase in which small-N coexisted with large-N with inferential statistics as the "treatment" (Phase B), then the question is, what follows? The B phase characterized by either small-N or large-N with inferential statistics, not both small-N and large-N without inferential statistics as in Phase A? In other words, does the next phase represent a return to baseline? What follows in the next section discusses the research and pedagogic prerequisites paving the way for achieving a cumulative science in that next phase.

Methodological Imperatives for the Way Forward: Towards a Cumulative Psychological Science

Repeatability, reproducibility, and replication are essential for the "self-corrective characteristic of scientific knowledge" (Branch, 2014, p. 261; see also Bertamini, 2023; Bishop, 2019). As the theory of evolution

abundantly illustrates (Zeigler, 2012), striving for a cumulative psychological science is a worthwhile endeavor. Grice et al., (2017) have identified important factors, some of which will be considered further below, that may well stand in the way of achieving such laudable feat.

Requisite Research Practice Conditions for Building a Cumulative Psychological Science

There are so many current practices in psychological research that need to be scrutnized and/or abandoned (see Wasserstein et al., 2019). Wasserstein et al. provide a litany of bad or perilous activities that psychological researchers engage in with respect to analysis and interpretation of NHST and *p*-values, which require shedding for productive change toward achieving a cumulative science. Fortunately, they offer a list of "thoughtful" things that can be done right toward that end, including distinguishing exploratory research from theory testing (much like Colling & Szucs's (2021) described above) with the requisite appropriate statistical testing. There will be a need for judicious use of or reliance on hypothetical constructs (MacCorquodale & Meehl, 1948), which tend to lead to reinfication of psychological terms (see Holth, 2001) that then engender weak or inadequate measurement practices, such as neglect of "measurement invariance" in the use of psychological scales (Maassen et al., 2023, *passim*; see also Boring, 1961). Problems persist in the form of averaging responses on measurement scales in psychological research (see Grice et al., 2017) that require critical attention and solutions to advancing the scientific status of psychological attributes often taken for granted erroneously. There needs to be a shift from hypothetical constructs to greater focus on *processes*, individual as well as group processes (e.g., De Dreu & Gross, 2019). Furthermore, psychological researchers need to dissociate methodology with particular subject matters, such as in social psychology being inexurably tied to group designs; among other things, as would be clearer in the next section, the research question rules!

Requisite Pedagogic Conditions for Building a Cumulative Psychological Science

Besides research practices of psychologists, in addition, research methods and statistics textbooks would need to 1) focus on both NHST *and* Bayesian inference in their coverage (see Szucs & Ioannidis 2017b); 2) cover both large-*N* group designs and attendant statistical assumptions and requirements *and* small-*N* individual research designs; and 3) focus on dictates of the research purpose first and foremost, in addition to the statistical requirements. Pedagogic considerations then must take all these into account in educating the next generations of psychological researchers.

Finally, to realize the objective of achieving a cumulative science, psychology would need to overhaul the current parallel methodological traditions for a somewhat integrated dynamic system driven by new insights into the research enterprise. The bane of psychology has been the tendency towards ritualization of its processes (see Imam, 2021). Current solutions being offered in response to the confidence crises in psychology can readily become ritualized, such as was feared for effect-size reporting (Davidson, 2018), may happen for preregistration, etc., creating an illusion of effective monitoring of the research processes and reporting

practices. For such overhaul to hold, new ways of doing the business of conducting psychological research would have to be appreciated and adopted.

Proposed Way Forward: An Overhaul of Current, Parallel Methodological Traditions

The Nature of the Overhaul

As Figure 5 depicts, first and foremost, the research cycle fundamentally changes, begining with the research question per se (not the standard hypothesis formulation of the group design) and only then initiating a design question, specifically whether one requires an extensive or an intensive study (not informed by statistical considerations as is done typically). If the research question suggests an intensive study that entails individual-level process or mechanism requiring repeated measurement, then a small-N design is indicated and adopted. Otherwise, if what is suggested is not an intensive study, then some other methodology is required; for example, focus groups. If, however, an intensive study is suggested but not at individual level, again some other kind of study is involved, perhaps qualitative in nature. It could even be a case study (Poling et al., 1995) when repeated measurement is not involved in the individual-level process.

What inferential statistics is appropriate for the group design is determined by whether or not the goal of the research question is estimating population parameters (only this goal initiates consideration of statistical requirements by virtue of adopting group designs). Indeed, as Grice et al. pointed out, for example, "psychologists can ask a simple question, 'Is drawing random sample critically important for my proposed research?' If the answer is in the affiramtive, then it is likely their intention is to seek inference to population parameters" (2017, p. 69). Unfortunately, this question does not come up at this point in the research cycle in current practice and we end up using convenient samples to the detriment of inference (see Grice et al., 201. If estmating population parameters is not indicated, then a large-N study without statistical significance testing of the type employed by Guilford and Dallenbach (1925) and Oberly (1928) of old is adopted. Lest one assume their methods were archaic, Grice et al. (2020) provide a bridge to the past in terms of the kind of modern analysis that are condusive to handling the sort of comparisons the earlier authors sought in executing large-N experiments without significance testing then. When group processes are indicated from an extensive study by the research question and a group design is used, the statistical requirements to be met are dictated by the nature of the experiment, exploratory or theoretical: 1) if exploratory, NHST requirements would be satisfied (e.g., alpha, power, sampling, etc.) to be acceptable, and 2) if theoretical, Bayesian requirements would be satisfied (e.g., adequately sourced priors, etc.) to be acceptable. In the event that extensive study without an interest in estimating population parameters is indicated, the large-N without inferential statistics would be adopted with the kinds of analyses suggested by Grice et al. (2020)—not depicted in Figure 5.

Figure 5 acknowledges other research methods available to psychological researchers, including but not limited to qualitative methods, case studies, focus groups, observational methods, content or narrative analysis, etc.

These sets of methods are usually not quantitative in nature and may not require the same levels of statistical analyses such as may be necessary for large-N group designs nor, for that matter, subject to experimental manipulation as is common in small-N designs. The exclusion of experimentation in these approaches may, in many cases, be due to ethical limitations or considerations, which preclude the possibility of the deployment of the experimental approach. Consequently, they are not directly relevant to the recommended overhaul in the present paper.
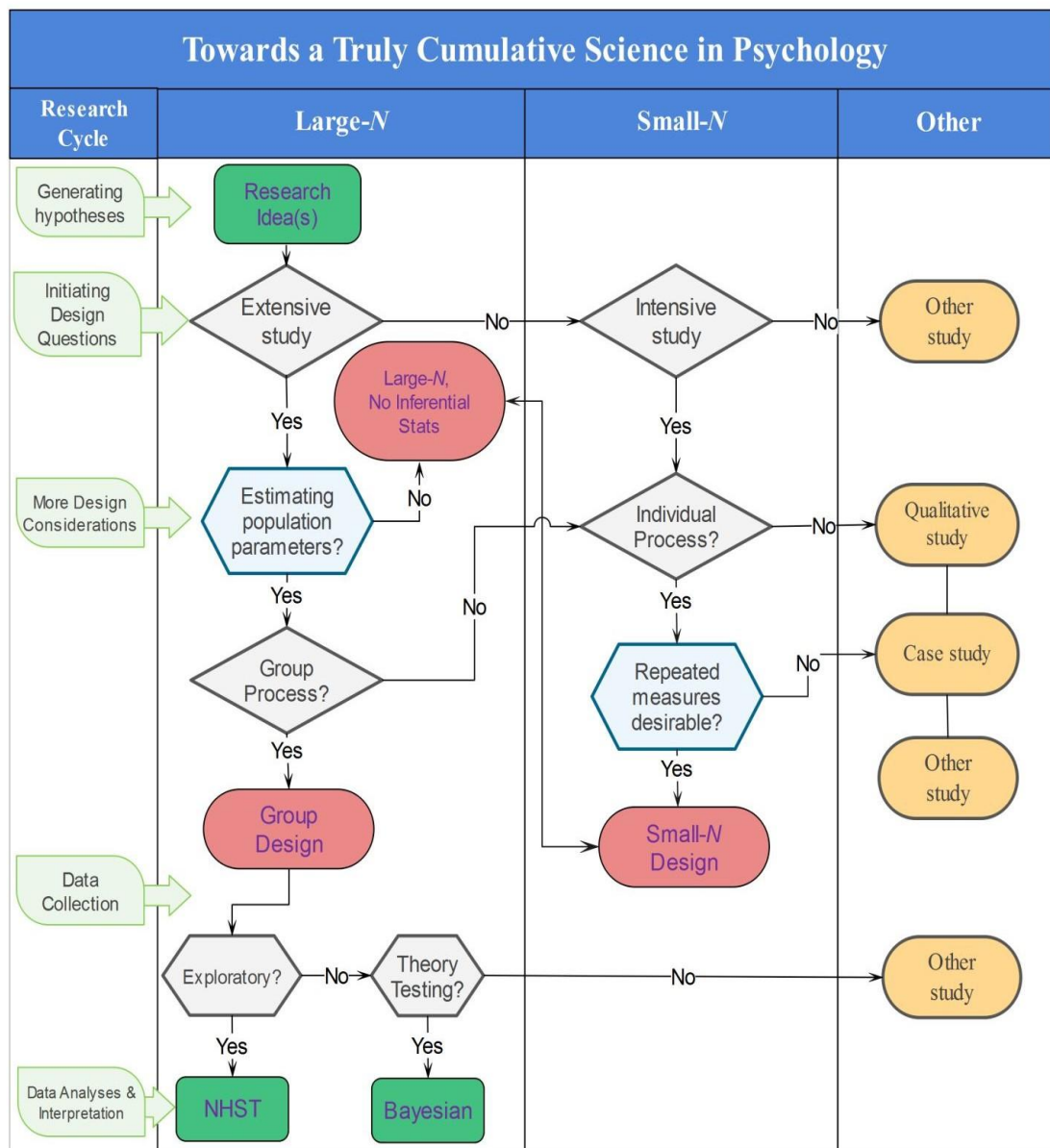
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Figure 5. New recommended research cycle and decision algorithm for choosing research designs and statistical testing methods in psychological research

Implications of the Overhaul

Adopting an overhaul such as represented in Figure 5 would require a significant shift in how we approach doing psychological research. For example, asking questions would no longer be determined by the typical pre-experimental statistical considerations based on assumptions that are common in mainstream psychology. Designing experiments would no longer be a straight forward question of either group or individual designs by default. The research question would dictate which general approach to adopt, large-*N* or small-*N*, which then initiates further design considerations, such as parameter estimation on the large-*N* group design side or need for repeated measurements on the small-*N* design side. On the group design side, statistical requirements then must be satisfied before data collection and analysis. Collecting data in group designs, for example, would have to respect sampling requirements and not automatically default to convenient samples as is the current practice. No longer would automatic snapshot, aggregate measures be the order of the day. Intensive, in-depth data collection under a small-*N* design also would work as dictated by the research question, just as with extensive large-*N* studies not focused on parameter estimation, but the kind of comparison that requires persons effect sizes (see Grice et al., 2020), for example.

Analyzing and interpreting data would no longer straightforwardly default to NHST with all its attendant problems, but instead require a more sophisticated, considered decision making on choice and implementation of statistical inference if or when required. Indeed, even the use of large-*N* per se would no longer default to significance testing which would be required now only for estimating population parameters. Making important research and practice decisions, overall, then would be based on revealed functional relations, not just on statistical imperatives.

These impliactions suggest that what is required is not just statistical reforms as has been the focus to date in response to the replication crisis. As Szucs and Ioannidis put it: "Rather than mere statistical reform, what is needed is for scientists to become better at inference (both Frequentist and Bayesian) and for a better understanding of how to use inferential strategies to justify knowledge" (2021, p. 144).

Conclusions

To begin the journey towards achieving a cumulative psychological science, business as usual with statistical and scientosocial tinckering is not an adequate option. To realize a cumulative psychological science requires a new approach in which we begin to focus on our research endeavors to behavioral and mental *processes*. A path to that end is to handle our unfettered focus on hypothetical psychological constructs that promote reification of psychological terms and inadequate measurement practices that hamper replicability of psychological findings. Tantamount to a major overhaul of psychological research as we know it, the proposed alternative provides a synergy of eclectic perspectives and approaches informed by *processes*, not just statistics.

With the overhauled methodological approach,

- o Research questions, not inferential statistical considerations, dictate research design
- o Any research question may be addressed using either or both large-*N* and small-*N* designs *without* inferential statistics
- o Only interest in population parameters dictates use of group designs, which is no longer the default adoption
- o Research interest in exploratory questions or theoretical testing dictates use of NHST or Bayesian statistics, respectively (the latter can no longer be ignored by default)
- o Focus on research questions readily permits alternatives to NHST and even Bayesian approaches; effect sizes construed as persons is one such candidate as a throwback to the old tested practices of the 1920s.

Reporting practices accommodate differences in research questions, interests, and goals. Current interventions on the replication crisis that have fallen to editors, reviewers, and authors alike would need to extend to further reorganization of research, analytic, and reporting practices, based on the proposed overhaul.

Recommendations

- o Reconsider old practices and reexamine why and how you conduct psychological research; the old ways are not working, not for a cumulative science
- o This proposed new way of doing the psychological research business directs your attention to the research question and its significance, not statistical significance
- o Consider your own contribution to the effort of achieving cumulative psychological research

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Digital Game Addiction among Turkish High School Students: A Survey of a Mediterranean City

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Abstract: It is an undeniable fact that technology shapes many areas of people's lives such as education, transportation and entertainment. The concept of the game is an educational and entertaining activity that has taken an important place in individuals' lives since the beginning of human history. With the development and spread of technology, individuals' understanding of gaming is also changing and digital games are replacing traditional ones. Whereas digital games have positive aspects to players, excessive use may also lead to negative consequences such as addiction. Being designed as survey research, this study explored the status of digital game addiction among the high school students in the largest Mediterranean city of Türkiye. Using convenience samples, the participants was made up of 117 voluntary students. Data were collected through an online questionnaire form including demographic information, game playing profiles and a scale for game addiction. Participants reported spending an average of 2.6 daily hours on digital gaming. The mean addiction score indicated that participants as a whole had a near-medium level of game addiction, with one fifth being diagnosed as addicted to digital games. Males had higher addiction scores than females. Those playing games mainly on the computer had higher addiction scores than others playing games mainly on the smartphone. The addiction scores were positively and moderately correlated with daily time spent playing games. On the other hand, the addiction score was not dependent on family status, parenting style, and the ownership of computers, tablets, smartphone and home internet.

Keywords: Digital Games, Addiction, High School Students, Demographics, Survey

Introduction

The concept of games is an educational and entertaining activity that has taken an important place in individuals' lives since the beginning of human history. Games are a voluntary activity that is structured

according to rules, is unpredictable, does not involve any obligations, has time and place limitations, is interactive, attracts the players, and sometimes has measurable results (Salen & Zimmerman, 2003). It is an activity that has constantly guided people's learning and shaped society and culture (Sezgin, 2016). From a cognitive point of view, Akın (2008) defines game as an activity that occurs in the sensory organs, nerves and muscles, and at the mental level, and is sometimes repeated with physical experiences. Game gives people the chance to benefit from the environment and each other so that they can participate by speaking, moving, writing, observing, and exhibiting emotional attitudes, and be affected by the environment and exhibit similar behaviors to each other (Tuğrul, 2014). Children's seeing the world as a game is the most important element in helping them achieve the competencies that life will demand from them in the future, when they reach the required competencies in cognitive, affective and physical situations.

It is an undeniable fact that technology shapes many areas of people's lives such as education, transportation and entertainment. Therefore, with the development and spread of technology, individuals' understanding of gaming is also changing and digital games are replacing traditional ones (Hazar, 2016). The digital game industry started with the release of Computer Space, which is called the first commercial game in 1971, and today it has billions of budgets and users all over the world. Digital games, mostly referred to as video games in international literature, are linked to a scenario and played with audio-visual or sometimes tactile equipment. According to Sarpkaya (2021), these games simultaneously include video, digital and game concepts, have their own unique applications and content, have both a technological aspect because they are digital and video-based, and a cultural aspect because they are games, and can be played by anyone with technological tools. Digital games are the integration of games into the digital environment through devices such as computers, tablets and smartphones. Types of digital games include arcade games, computer games, console games, mobile games and other varieties (Yengin, 2012).

Griffiths (2002) stated that digital games attract the attention of almost everyone, regardless of demographic characteristics (age, gender, ethnicity, educational status, etc.). They offer a very lively and creative environment and thus contribute to the development of hand-eye coordination and provide the basis for the maturation of people's abilities and concepts. They also provide social cohesion through different relationships. They are more complex than they seem and require multi-dimensional abstraction (Kaya, 2013). They help realize self-identity, which will become a motivation factor for participation in the gaming community (Zhang & Shang, 2016). Whereas digital games have abovementioned positive aspects on players, excessive use may also lead to negative consequences such as addictive symptoms commonly experienced by substance addicts, including salience, mood modification, craving, and tolerance (Kuss & Griffiths, 2012a). Since digital games are cheap or free, easily accessible and can be played anywhere and 24/7 time, players may maintain constant motivation and playing desire and eventually use games as a way of escaping from the problems of daily life or coping with stressors, leading to the development of game addiction (Kuss & Griffiths, 2012b). Since most addictions develop in early adulthood, the investigation of digital game addiction among adolescents and youngsters are very important to establish prevention efforts. With this in mind, in this study, we aimed to

explore the prevalence of game addiction among the Turkish high school students and its relationships with some demographic and contextual variables. In order to fulfill this purpose, we formed the following research questions:

1. What is the level of participants' digital game addiction?
2. Does the addiction level differ with regards to gender, family status, parenting style, ownership of various technological devices and home internet?
3. Does the addiction level relate to daily time spent on gaming?

Method

In accordance with the research purpose and questions of the study, we utilized survey methodology within the context of quantitative research. Survey is a research model that allows the description of tendencies and attitudes based on the determined sample. In addition to defining the distribution of variables in a sample, it also examines relationships between them through either correlational or comparative approaches (Creswell, 2017; Karasar 2005). The nature of the present study is greatly comparative since the focus is on exploring not only the prevalence of digital game addiction among the participants but also the association of addiction with some demographic and contextual factors that were measured as categorical variables.

Using a convenience sampling to overcome time and financial limitations, the sample comprised 117 volunteer and easily accessible Turkish high school students who were living in the city of Antalya at the time of the study. Since the survey is research that examines the characteristics of sample group without any intervention (Büyüköztürk et al., 2013), we measured all the variables at the same time with no manipulation through an online questionnaire form. This form is comprised of three main parts. The first part informed participants about the research purpose and consent form and asked them to indicate their demographic characteristics. The second part collected contextual information about the participants' digital gaming habits and profiles. The final section included Digital Game Addiction Scale (DGAS) for adolescents developed by Hazar and Hazar (2017). The DGAS has 24 items rated on a 5-point Likert-type scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). We created a composite variable by summing item scores, which could range from 24 to 120 with higher scores indicating severe addiction. Hazar and Hazar (2017) validated it on a sample of students through conducting exploratory and confirmatory factor analyses and reported Cronbach alpha internal consistency coefficients as .90 for the whole scale, which we calculated as .91 for the present study. They also determined cut-off points based on the total score of the scale as 1-24=normal, 25-48=low-risk, 49-72=risky, 73-96=addicted, and 97-120=highly addicted group.

Results

The frequency distribution of some demographic and contextual characteristics of the participants is given in

Table 1. Those students who were female (56%), who were living with their own parents (74%), and whose parents had authoritative (high control) parenting style (74%) were more than their counterparts. Most of them had a computer (58%) and a tablet (66%) at their home. The majority of the participating students had smartphones (91%) and home internet access (94%). The main gaming tool was reported as smartphone (55%), computer (32%) and tablet (13%). Participants were asked to write down how much time they usually spent for digital gaming per day. Descriptive statistics for this item revealed that the minimum number of hours per day was one and the maximum number of hours per day was eight. The mean hour was 2.56 with a standard deviation of 1.70.

Table 1. Distribution of Demographic and Contextual Characteristics

Variable	Group	f	%
Gender	Male	52	44
	Female	65	56
Family status	Divorced or at least one dead	31	26
	Own parents living together	86	74
Parental style	Authoritative (high control)	86	74
	Permissive (low control)	31	26
Ownership of computer	Yes	68	58
	No	49	42
Ownership of tablet	Yes	40	34
	No	77	66
Ownership of smartphone	Yes	107	91
	No	10	9
Ownership of home internet access	Yes	110	94
	No	7	6
Main gaming tool	Smartphone	65	55
	Computer	37	32
	Tablet	15	13

Table 2 presents the descriptive statistics for the participants' total scores obtained from the DGAS. As can be seen, the DGAS scores ranged from 24 to 94 with a mean score of 56.35 close to the midpoint of its scaling range. The standard deviation value is 18.66, which shows moderately narrow dispersions of the data, suggesting that participants' scores are closely clustered around the meaning. Additionally, skewness (-.34) and kurtosis (-1.03) values were between the threshold values in the literature (+1.5 and -1.5) suggesting that the DGAS scores were normally distributed (Tabachnick & Fidell, 2013). Table 3 summarizes the distribution of DGAS scores according to the cut-off criteria described by Hazar and Hazar (2017). While almost half of the participants (48%) were in the risky group, 20% of them were in the addicted group. Pearson correlation coefficient between the DGAS scores and daily time spent on gaming was calculated as .59 (p<.01), indicating a

significant positive and moderate level association.

Table 2. Descriptive Statistics for the DGAS Score

Variable	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
DGAS score	24	94	56.35	18.66	-.34	-1.03

Table 3. Distribution of the DGAS Scores by Cut-off Points

Score range	Diagnosis	f	%
1-24	Normal	10	9
25-48	At low risk	27	23
49-72	At risk	56	48
73-96	Addicted	24	20
97-120	Highly addicted	-	-

We conducted a series of independent samples t-test to compare the DGAS scores across some demographic and contextual characteristics. Their results indicated that students' DGAS scores did not differ significantly with regards to family status, parental style, ownership of computer, ownership of tablet, ownership of smartphone, and ownership of home internet access (p>.05). On the other hand, regarding their gender, male students (Mean=64.69, SD=12.00) had higher scores that female students (Mean=49.68, SD=20.37) and this difference was statistically significant (t=4.96, p<.01).

Table 4. Comparison of the DGAS Scores by Demographic and Contextual Characteristics

Variable	Group	Mean	SD	t	p
Gender	Male	64.69	12.00	4.96	.00
	Female	49.68	20.37		
Family status	Divorced or at least one dead	60.71	15.15	1.72	.09
	Own parents living together	54.78	19.62		
Parental style	Authoritative (high control)	55.78	19.32	-.55	.58
	Permissive (low control)	57.94	16.91		
Ownership of computer	Yes	58.35	17.68	1.37	.17
	No	53.57	19.79		
Ownership of tablet	Yes	57.78	17.78	.59	.55
	No	55.61	19.18		
Ownership of smartphone	Yes	56.92	18.22	1.07	.29
	No	50.30	23.12		
Ownership of home internet access	Yes	56.10	18.21	-.24	.81
	No	57.07	20.22		

Moreover, we conducted a one-way between-groups analysis of variance (ANOVA) to compare the students' DGAS scores across main gaming tool they most frequently used for gaming activities. The results indicated a significant difference (F=9.02, p<.01). Failing to assume homogeneity of variance, we conducted Dunnett's C post hoc test and found that students who preferred to play games mainly on a computer (Mean=65.27, SD=13.91) had higher scores than those playing mainly on a smartphone (Mean=50.35, SD=19.74).

Table 5. Comparison of the DGAS Scores by Main Gaming Tool

Variable	Group	Mean	SD	F	p
	Smartphone	50.35	19.74		
Main gaming tool	Computer	65.27	13.91	9.02	.00
	Tablet	60.33	14.61		

Discussion and Conclusion

The results revealed that participants spent an average of about 2.6 daily hours on digital gaming, suggesting that playing digital games is a popular and regular activity among the high school students in Türkiye. The most preferred or mainly used gaming tool is smartphones followed by computer and tablet. These findings related to Turkish context are corroborating with the global ones. According to the "Digital 2024: Global Overview Report", the percentage of internet users aged 16 to 64 who play games was 94.8% for Türkiye and 83% for the worldwide and of the global users 67.7% play games on a smartphone, 35% on a desktop or laptop computer, and 16.3% on a tablet (Datareportal, 2024).

The mean addiction score indicated that students as a whole had a near-medium level of game addiction, with one fifth (20%) being diagnosed as addicted to digital games. This is a quite high prevalence rate compared to previous studies because systematic reviews of international research indicate that the global prevalence rate in general population ranges from 0.7% to 27.5% (Sidik, 2020). The variation in prevalence rates can be caused by study population, cultural factors, and assessment or diagnostic criteria. The majority of the research comes from the Asian and Western countries, and little is known about Middle East. The present study shows that almost half of the participants are at risk of game addiction. This is an alarming result because the situation might get more severe in couple of years when students enter to the university life where they have easy and free access to digital tools, more spare times and less parental/family control.

As far as the differences in game addiction with regards to demographic and contextual factors are concerned, male students have higher addiction than female students. Although digital games have become easily accessible to men and women, the fact that the areas where digital games are played, and their content are more suitable for males may be explaining this situation. Furthermore, digital games are still known mostly male-dominated type of gaming in some parts of the world like the Middle East. Students who play games mainly on the computer have higher addiction than those who play mainly on smartphones. This is an expected result because computer

environments offer more audio and video effects and high interactions, which motivate players as well as feed addictive behavior.

Research regarding game addiction is a rapidly evolving field and findings may change with new studies being conducted. Further studies may focus on comparing cohorts in different regions, countries or cultures. Future studies can explore whether addiction scores differ according to type of game. Multiuser games may be more addictive than individual player ones due to peer motivation and engagement. School can raise awareness of the condition among their students as well as offer cognitive behavioral therapy as a first-line therapy to improve addiction symptoms especially for those risky students.

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Pre-service Teachers' Personal Data Privacy Awareness Levels and Related Behaviors in Online Environments

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Abstract: While there are many conveniences that the widespread use of the Internet provides us today, there are also some risks that come with these conveniences. One of these risks is the disclosure of personal data. Personal data can be defined as any information regarding an identified or identifiable real person. It can be argued that wide use of digital environments makes it easier to access, collect and share personal data. This highlights the importance of having necessary knowledge and skills about sharing and protecting personal data, especially for university students who are actively involved in digital platforms. Therefore, this study aimed to investigate pre-service teachers' awareness levels and related behaviors of personal data privacy in online spaces. It was designed as a small scale survey within the context of quantitative research methods. Using a convenience sampling, participants were made up of 76 students enrolled in various teacher education programs in a major university in Türkiye. Data were collected through an online questionnaire form developed using relevant studies in literature. While the majority of the participants were found to be aware of the concept of personal data and its privacy and protection, approximately half of them were not aware of the regulation on this subject. They reported security (law enforcement), health and public institutions as the institutions they trusted most in protecting personal data. They stated that they did not share their personal data when filling out online surveys and using free trials of any software. Most preferred to share their names, photos, videos, schools, towns but not to share phone numbers, addresses and e-mails on social media. They tend to contact the police instead of the Prosecutor's Office and the relevant board in case their personal data is misused.

Keywords: Personal Data Privacy, Online Security, Awareness, Behaviors, Survey

Introduction

The general term "data" is defined as the representation of the main elements and facts, concepts or commands

that are the basis of a research, a discussion, a judgment, in a format suitable for communication, interpretation and operation in the Turkish dictionary (TDK, 2024). According to the Turkish Personal Data Protection Authority (KVKK), "personal data" is any information regarding an identified or identifiable natural person (KVKK, 2019). In order to be considered personal data, the data must relate to a natural person and this person must be specific or identifiable. Therefore, protection of personal data basically aims to protect not the data, but the people to whom these data are related. It refers to administrative, technical and legal measures for the purpose of protecting individuals from damage arising from the full or partial processing of their personal information.

The term "privacy" is defined as the state of being secret (TDK, 2024). Personal data privacy can be expressed as the right of people to decide for themselves to what extent they can share things about their lives with other people (Karagülle, 2015). The concept of privacy is a concept that can vary from culture to culture, from time to time and even from individual to individual. Privacy is generally or traditionally considered in three dimensions: (a) territorial privacy, which is privacy regarding the physical space surrounding a person, (b) personal privacy, which represents unnecessary interference with an individual's physical existence, and (c) informational privacy, which deals with the collection, storage or control of how personal data may be processed and distributed (Kokolakis, 2017). However, the scope of personal data privacy has further expanded in recent years due to the developments in technology. A variety of technological tools and contents have been produced and they make it easier to access information that makes a person's identity identifiable. Individuals' personal profiles can be easily revealed by collecting people's online footprints through data analysis methods (Eroğlu, 2018). The perception of privacy loses its traditional perception with technology and gains a different meaning (Çaycı & Karagülle, 2014).

Those images and videos, which were traditionally considered private, are today shared with the world through online platforms and mutual conversations, relationships and friendships are carried out openly in social networks. At this point, a culture of sharing emerges and hence individuals are trying to introduce themselves to society in the virtual environments. They display all kinds of personal information through internet networks, from their religious beliefs to which political party they voted for, who they are friends with, and where they are by reporting their location. This makes it easier to access, collect and share personal data and calls for the risk of disclosure of personal data. Therefore, it is important to have the necessary knowledge and skills about sharing and protecting personal data, especially for university students who are actively involved in digital platforms. This research study aims to investigate pre-service teachers' awareness levels and related behaviors of personal data privacy in online spaces.

Method

We designed our study as a descriptive survey within the quantitative research paradigm since we intended to reveal pre-service teachers' current perceptions and behaviors related to personal data privacy in their own

conditions without any manipulation or intervention. Survey design is known to be cheap and quick and usually utilized collecting quantitative data germane to assessing opinions, perceptions or attitudes from a accessible sample recruited from a population that is too large to observe directly (Büyüköztürk, Kılıç, Çakmak, Akgün, Karadeniz & Demirel, 2011; Kuş, 2012). We determined the accessible population of this research as teacher candidates studying at the College of Education at Süleyman Demirel University located in the western part of the Türkiye. The most frequently used approach to collect data in survey research is questionnaire, which is often either a paper-and-pencil document or an online form comprising questions asked to acquire required information from the study participants (Büyüköztürk et al., 2011). With this in mind, we developed an online questionnaire form through the Google Forms in accordance with the review of related literature including similar questionnaires (e.g., Eroğlu, 2018) and expert consultation. The second author, who was also a senior student at the same college, shared the aim and scope of the research along with the URL of online questionnaire in the student email lists, WhatsApp groups and social media. She invited her peers to voluntarily fill out the form and posted it on the web for about a month. Therefore, using such a convenient sampling approach, our sample was made up of 76 students who completed the questionnaire. Table 1 summarizes the demographic profiles of the participants. As can be seen from the frequency and percentages, most participants were female (76%) and almost half of them were majoring in primary education (42%) although there were participants representing each department. The sample also had enough participants to represent each year's group of the college as they were not distributed in a way that dominates any group.

Table 1. Demographic Characteristics of the Sample

Variable	Group	f	%
Gender	Male	18	24
	Female	58	76
Major	Primary education	32	42
	Computer education	16	21
	Foreign language education	10	13
	Science education	7	9
	Turkish education	6	8
	Mathematics education	5	7
Year	Freshman	16	21
	Sophomore	24	32
	Junior	13	17
	Senior	23	30

Results

The descriptive statistics from Table 2 showed that 93% of the participants knew about the concept of personal data and 90% of them recognized their rights germane to the protection of personal data and privacy. However,

almost half of them (45%) did not know or hear anything about the laws specifically designed for personal data protection. Most (66%) got phone calls asking for their personal data and majority of them (80%) reported that the caller introduced himself/herself. They tend to share their data if they know the caller (61%) and carefully read the information note related to the use of personal data by either persons or organizations (87%).

Table 2. Awareness Level for Personal Data

Item	No		Yes	
	f	%	f	%
I know the concept of personal data	5	7	71	93
I am aware of rights such as protection of personal data and privacy	8	10	68	90
I am aware of the Personal Data Protection Law	34	45	42	55
I get phone calls asking for my personal data	26	34	50	66
The caller introduces herself/himself	15	20	61	80
If I know the caller, I share my personal data with her/him	30	39	46	61
I carefully read the information text regarding the personal data	10	13	66	87

Considering who or which institutions participants should contact if they want to complain about the misuse of their personal data; 51% of them stated that they would apply to the police, 21% to the Personal Data Protection Board, and 17% to the Public Prosecutor's Office. If their personal data has been misused in the past and they have not filed a complaint, the reasons for this included that they did not think that this situation was important (13%), they did not know how to complain (16%) and they did not know where to complain in such a situation (19%).

Table 3. Trust Level in Institution for the Protection of Personal Data

Institution	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Police	1	5	3.96	1.34	-1.29	.42
Health institutions	1	5	3.71	1.18	-1.08	.45
Government agencies	1	5	3.38	1.22	-.73	-.37
Banks	1	5	3.03	1.39	-.17	-1.23
Municipalities	1	5	2.88	1.18	-.32	-1.01
GSM operators	1	5	2.78	1.30	.24	-.98
Private companies	1	4	2.25	.95	.23	-.88
Marketing/commercials	1	5	2.01	.96	.91	.87

Descriptive statistics regarding the participants' opinions about whether the institutions that collect their personal data protect the collected data correctly are given in Table 3. Their most trusted institution was police (M=3.96, SD=1.34) followed by health institutions (M=3.71, SD=1.18) and government agencies (M=3.38, SD=1.22). However, participants, on the average, did not seem to trust in private (M=2.25, SD=.95) and

marketing or commercial companies (M=2.01, SD=.96). When filling out forms or applications that ask for personal details, they reported to have answered every piece of information completely or correctly when applying for educational institutions (74%), public services (72%), banking services (70%), insurance services (69%), mobile communication providers (51%) and sport clubs (30%). On the other hand, they reported that they left the personal questions blank or anonymous when filling out the survey (45%), trying out free trial versions of products (45%), and applying for company membership cards (32%).

Table 4 presents the descriptive statistics on participants' tendencies to share personal information on the Internet platforms such as social media, blogs, personal web sites, and so on. It shows that they share their real names with 91% at most; followed by the school they attended and their photos and videos with 82%, and then the city they live in with 70%. On the other hand, 93% of the participants do not share their home address, 91% their license plates, and 58% their email addresses.

Table 4. Sharing Status of Personal Data on the Internet

Data	No		Yes	
	f	%	f	%
Real name	7	9	69	91
Phone number	57	75	19	25
Photo and video	14	18	62	82
School	14	18	62	82
City	23	30	53	70
Address	71	93	5	7
E-mail	44	58	32	42
License plate	69	91	7	9
Birth date	33	43	43	57

Discussion and Conclusion

Although the participants largely know the concept of personal data and they are aware of rights for the protection of personal data and private privacy, approximately half of them are not accustomed to the regulation on this subject. Based on this result, we can suggest that participants need to be informed about the related regulations. Although we did not investigate the channels through which the remaining half of the participants are informed about the laws in this study, it is reasonable to suggest that such information can be given online due to the widespread use of the Internet in accessing information, especially among the young people.

Our study shows that participants trust mostly in security (law enforcement), health and public institutions with regards to protecting their personal data. The reason for this is thought to be due to the public service duties that these institutions undertake to protect people's fundamental rights and freedoms. The reason for the trust in

health institutions may be due to the positive behaviors they have exhibited in the fight against the recent pandemic. The study reveals that participants do not share their personal data while using opinion surveys and free trial versions of the products or leave the sections where their personal data are asked blank. One reason for this may be that it is not known who will use their data and for what purpose, and that the participants do not trust the sites where the products are provided. Reading information texts regarding personal data requested by individuals or organizations is an important requirement to protect personal data privacy. The finding that the participants fulfilled this requirement at a high rate shows that the participants are aware of the subject.

While it is noteworthy that participants are most likely to complain to the police in case their personal data is misused, it is understood from the research findings that fewer will apply to the Personal Data Protection Board and the Public Prosecutor's Office, to which they should apply if they encounter such a situation. This shows that the participants have incorrect or lack of regarding the responsible institutions to be applied to and thus they need to be trained in this direction.

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Participants Views on Engaging with Female Faith Actors to Improve Woman Rights and Prevent Violence Against Women (iENGAGE) Project Online Training

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Abstract: Violence against women is a grave violation of human rights and a form of discrimination against women. It can take many forms such as physical violence, sexual abuse, stalking, or forced marriages. Faith actors can be part of the solution rather than the problem when working and advocating for gender justice. iENGAGE project aims to address the underlying root causes of violence against women, particularly by engaging and equipping women faith actors to transform the attitudes, behaviors and social norms within their communities that support gender inequality and enable violence against women. As part of the project, 230 women were trained in Tokat, Gaziantep, Trabzon, Isparta and Ankara as part of the Leading Women Trainers program, providing them with adequate skills and literacy in the prevention of violence. During the project, training curricula were developed for women faith leader candidates in various professions, mainly teachers, students, civil servants, mufti's office employees and Quran courses instructors, focusing on improving their capacities to play an active role in women's rights and preventing violence against women. The training curricula covered a total of 60 days for each training course over a period of five months. iENGAGE project attracted great interest in all provinces within the implementation area and we realized our trainings with 230 participants, exceeding our commitment of 100 participants. Research results show that the majority of participants in the training curricula are satisfied with the training content. Participants stated that the training provided them with knowledge and skills on the subject, that participation was encouraged, and interaction was high, and that they believed that the training would contribute to their individual and professional development. The research also found that the participants' training contributed to their professional personal development.

Keywords: Faith Actor, Woman Rights, Training, Violence

Introduction

Gender-based violence (GBV) is a pervasive form of gender injustice that impacts millions of girls and women worldwide, deeply entrenched in societal gender norms and practices (Alhabib, Nur & Jones, 2010). Globally, more than one in three women experience intimate partner violence (WHO, 2012). GBV is a leading cause of death, illness, and disability among women of all ages, with devastating effects on both the victims and their communities. It poses a significant barrier to women's equal rights, including their participation in society, citizenship, and access to and control over resources (Alaman & Yıldız, 2014).

Violence against women is a grave violation of human rights and a form of discrimination against women. It can take many forms such as physical violence, sexual abuse, stalking, or forced marriages (Basar & Demirci, 2018).

Globally, one in three women have experienced physical or sexual violence in their lifetime. Violence against women is a global human rights abuse, harming social and economic development. According to Domestic Violence against Women in Turkey (2015) by Hacettepe University, 36 percent women (approximately 4 out of every 10 women) aged between 15-59 subjected to physical violence by their husbands or intimate partners (Guvenc, Akyuz & Cesario, 2014).

Furthermore, the global lockdown (The outbreak of COVID-19) triggered an upsurge in domestic violence and exacerbated the existing socio-economic vulnerabilities of women all over the world (UN_Woman, 2020). Violence against women (VAW) is a form of gender injustice which affects millions of girls and women in Turkey and is deep rooted in social gender norms and practices (Özcan, Günaydın & Çitil, 2016). VAW is a leading cause of death, illnesses and disabilities of women at all ages. Furthermore, violence against women and girls is both a cause and a consequence of unequal power relations between women and men and it limits the full advancement of women.

Violence against women is recognized as a serious violation of human rights and a threat to the peace of societies all over the world. The role of social leaders and especially religious leaders is of great importance in preventing this problem. As trusted guides in their faith communities, women religious leaders have the potential to raise awareness about preventing violence against women and bring about positive change in society. By interpreting religious texts correctly, these leaders can deliver messages that defend women's dignity and rights, raise awareness on gender equality, and stand out as strong role models who stand against violence. The contributions of women religious leaders in this field can contribute to the development of permanent solutions to combat violence against women by getting to the root of the problem.

The role of women religious leaders in preventing violence against women is critical to protecting and strengthening women's rights by supporting social transformation.

Faith actors can be part of the solution rather than the problem when working and advocating for gender justice. In Turkish context, religious leaders are the most respected figures in their communities and every domain of public life (Heper, 1997). They have unique reach and influence within the community. If mobilised and equipped, they could play a key role in more effective prevention of and response to VAW and woman rights. Specifically, female religious actors, including female faith leaders, can play important roles in promoting gender justice, women rights, and preventing violence against women in communities and within faith institutions.

Empowering religious female actors to occupy leadership positions in religious institutions is part of a strategy relying on women of faith as change agents. In addition, engaging female faith actors helps to provoke critical discussions and understanding around religion related gender based violence issues. They may play a powerful role in shaping attitudes, opinions and behaviours. They can shape social norms, and they have the power to promote and support laws and public policies ensuring respect for women's rights in line with faith-based teachings.

Women faith actors will be trained to increase their capacity and leadership skills confidence and assertiveness in their roles as faith and community leaders to play an active role improving women's right and preventing violence against women.

Engaging faith actors and religious leaders—both women and men—at local, national, and global levels can significantly contribute to changing harmful norms, supporting survivors, and influencing legislative processes that address discriminatory laws. Faith leaders have the potential to play a transformative role, alongside people of faith, in addressing the root causes of gender inequality and GBV by speaking out from both moral and political standpoints. In doing so, they become part of the solution rather than part of the problem.

Violence against women is a grave violation of human rights and a form of discrimination against women. Faith actors can be part of the solution rather than the problem when working and advocating for gender justice. In Turkish context, religious leaders are the most respected figures in their communities and every domain of public life. They have unique reach and influence within the community.

iENGAGE project aims to address the underlying root causes of violence against women, particularly by engaging and equipping women faith actors to transform the attitudes, behaviours and social norms within their communities that support gender inequality and enable violence against women.

Method

During the project, training curricula were developed for women faith leader candidates in various professions, mainly teachers, students, civil servants, mufti's office employees and Quran courses instructors, focusing on

improving their capacities to play an active role in women's rights and preventing violence against women. Data was collected through Google Forms.

The training was carried out via online platforms. Participants were selected from the provinces of Isparta, Trabzon, Ankara, Gaziantep and Tokat. The training curriculum was spread over a five-month period covering five different topics. The training was planned to last 60 days in total.

The iENGAGE project attracted great interest in all provinces in the application area and was successfully completed with 230 participants, exceeding the target number of 100. Within the scope of the project, 230 women were trained within the framework of the Leading Women Trainers program in the provinces of Tokat, Gaziantep, Trabzon, Isparta and Ankara. In this way, sufficient skills and literacy were acquired to prevent violence.

Training Topics of the iENGAGE Project

Gender Equality and Discrimination

- Gender equality
- Distribution of roles in the family by gender
- Women's invisible/unpaid domestic labor
- The place and representation of women in society, media and education
- Women's Access to Rights (Economic, Political, Health, Education)
- Women's Participation in Decision-Making Processes
- Types of Violence and Application Mechanisms in the Event of Violence

Gender Roles and Family Communication Skills

- Improving Communication Skills in Violence Prevention
- Spousal Relationships and Coping with Stress,
- Improving Communication Skills in Violence Prevention
- Anger Management
- Prevention of Domestic Violence
- Peer Compatibility
- Prevention of Domestic Violence
- Effects of Domestic Violence on Children
- Partner Selection

Ways for Women Subjected to Violence to Reach Justice

- Constitutional Basis of Gender Equality

- International Legislation in Combating Violence Against Women

- National Legislation in Combating Violence Against Women

- Law No. 6284 on the Protection of the Family and Prevention of Violence Against Women and its Implementation Regulation

- Ways for Women Victims of Violence to Reach Security and Justice, Administrative and Judicial Methods, Institutions and Organizations to Cooperate with

Women's Health, Women's Reproductive Health and Rights

- Women's General Health,

- Women's Anatomy, Hormones, Menstruation

- Hygiene

- Pregnancy

- What is Pregnancy and Birth, Miscarriages, High Risk Pregnancies, Maternal Mortality and How to Prevent it

- Women's Reproductive Health and Family Planning

- What is family planning, Protection methods, Factors affecting reproduction

- Reproductive Rights and Ideal Reproductive Age

- Women's Role in Marriage and Having Children, Ideal Reproductive Age for Mother and Baby Health and Harms of Child Pregnancies

Ways for Women and Women Subjected to Violence to Express Themselves on Digital Platforms

- Social Media and Women's Rights

- Violence Against Women on Social Media

- The Role of Social Media in Raising Awareness of Violence Against Women

- The Role of Social Media in Preventing Violence Against Women

- What to Consider When Using Social Media?

- How to Report Violence on Social Media?

Results

Participants consist of 221 participants who agreed to participate in the study voluntarily in various provinces of Turkiye. The chart below shows the number of participants according to where the training was held. When Figure 1 is examined, it is seen that the highest participation in education is provided in Tokat province. Subsequently, participation in the training was provided in the provinces of Isparta and Trabzon. The least participation was in Gaziantep and Ankara provinces.
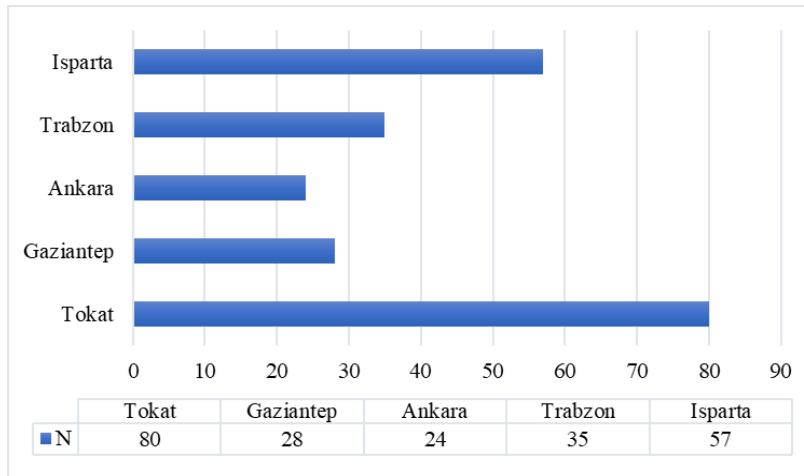
Figure 1. Number of Participants by Location of Training

Participants' opinions about the content of the training are also included. They were asked to rate their opinions about the content of the training as *1-Strongly Disagree, 2-Disagree, 3-Undecided, 4-Agree, 5-Strongly Agree*. Findings regarding this are given in Table 1.

Table 1. Participants' Opinions about the Content of the Training

	Medium
Education gave me new knowledge and skills	4.88
I had the opportunity to correct and renew my existing knowledge during the training	4.86
The topics covered in the training met my needs	4.80
The objectives of the training were clearly defined	4.71
The topics that needed to be covered in the training were correctly identified.	4.68
The content of the training met its purpose	4.72
The topics covered were relevant to me	4.66
Participation and interaction were encouraging	4.69
The messages given on the subject were clear	4.68
Practical examples were sufficient	4.68
The visual and audio materials used made it easier for me to learn	4.64
The training increased my interest in the subject	4.66
Helped me keep up to date information	4.77
Training content was easy to organize and follow	4.70
I will be able to use the knowledge and skills I gained during training in daily life	4.66
The duration of the training was sufficient	4.72
I believe that education will contribute to my personal/professional development	4.70
Training started on time	4.75
Training was completed on time	4.82

According to the data in Table 1, it is understood that a significant portion of the participants were satisfied with the content of the training. Participants stated that the training provided them with knowledge and skills on the subject, that participation and interaction were encouraging, and that they believed that the training would contribute to their individual and professional development. In addition, the participants stated that the training objectives and contents were clearly defined, there were sufficient visual and audio materials for practice, and this made their learning easier.

Participants were asked to rate their opinions about the educators as *1-Strongly Disagree, 2-Disagree, 3-Undecided, 4-Agree, 5-Strongly Agree*. The results regarding this are presented in Table 2.

Table 2. Participants' Opinions about Educators

	Medium
The trainers were well prepared	4.90
They were knowledgeable about the training topics	4.88
They were able to reflect their experience on the subject to the training	4.86
They presented the content effectively and efficiently	4.72
They approached the questions positively and cared about answering them	4.69
They were able to focus attention on the subject	4.70
They encouraged participation	4.73
The trainer's voice was audible	4.72
The trainer was enthusiastic and enthusiastic while conveying his subject	4.71
The trainer's examples were interesting	4.68
He kept the course lively by motivating the participants	4.68
The trainers were in harmony with each other	4.66
The trainer summarized the subject at the end of his presentation	4.68
He used the time given to him effectively	4.79

When Table 2 is examined, the participants stated that the instructors had sufficient knowledge about the subject, that they presented their experiences on the subject effectively and efficiently, and that they motivated the participants and encouraged participation by keeping the course lively. In addition, the educators stated that they used the time given to them effectively and conveyed the subject with enthusiasm and enthusiasm. The research also asked the participants what aspects of the training they benefited most from a professional perspective. Some example statements regarding this are summarized in Table 3.

Table 3. Some Sample Expressions of Participants Regarding the Aspects of Education that
They Benefited Most from a Professional Perspective

The training contributed to my professional development.
Thanks to my training, I improved myself and progressed.

I think I have become equipped by taking advantage of all my training.
All my trainings were productive for me and thus I improved my skills. I made progress professionally.
I got maximum benefit from my training and learned new things.
I shaped my life with what I learned from my training.
Thanks to my training, I gained new and different perspectives.
Every education was an opportunity for me.
I left all my training with self-confidence.
I discovered my own potential in all my trainings.
I learned valuable information in all my training.
Thanks to my training, I learned skills that I can use throughout my life.
I revealed my potential by taking advantage of all my training.
In all my trainings, I discovered the most suitable learning methods for me.
Thanks to my training, I set new goals in my life and achieved them.
In all my training, I improved myself thanks to what I learned from my teachers.
By attending all the trainings, I gained knowledge and had the chance to apply it.
I increased my knowledge by taking advantage of all the trainings.
I reinforced my knowledge by understanding the content of all trainings.
I moved myself forward by completing all the training.
I had the chance to practically apply what I learned in all the trainings.
I improved my learning skills by taking advantage of all the training.
While completing all the training, I learned different skills from each one.
I improved myself in different areas by attending all the trainings.
I improved my professional skills by completing all training.

The training that the participants benefited from most in terms of their personal development is presented in Table 4.

Table 4. Some sample expressions of participants regarding the aspects of education
that benefited most from the perspective of their personal development

The training provided the opportunity to get to know my own body.
I liked the legal aspect.
My awareness of my women's rights has increased.
It helped me look at myself and my environment from a different perspective.
This training was very important for my personal development, and I made serious progress in this regard.
It made a great change in my personal development and gave me strength.
I can say that it opened new horizons and gave me a different perspective.

It has had a huge impact on my personal development, creating an unprecedented change. The training helped me understand myself better.
The education I received helped me discover open doors in my personal development. Therefore, this training created vitality and energy in my personal development.
The educational process helped me fill in the gaps in my personal development. It also took my personal development to the next level.
In fact, it created a radical change in my personal development.
It brought new abilities and skills to my personal development
Thanks to the training, I have made great progress in my personal development, and I feel stronger.
This training gave me an important vision and goal for my personal development.
It gave me more self-confidence and belief.
Thanks to the training, I saw a huge change in my personal development, and it affected my life in a positive way.
It has been an important journey in my personal development and has made me a better person.
While this training added a new experience to my personal development, it also helped me get to know myself better.
This training gave a new direction to my personal development, and I can manage myself better.

In the research, participants' opinions were also taken regarding what suggestions they might have for future trainings. Sample expressions regarding this are given in Table 5.

Table 5. Some Suggestions Expressed by the Participants for Future Trainings

Giving more space to both theoretical and practical applications
Their numbers can be increased and the participation of men must also be ensured.
Young people should be informed about choosing a spouse before marriage. Counseling centers should be increased. Platforms should be organized entirely in the form of question and answer sessions with young people.
It must be face to face. It should shed light on our profession.
Days may be extended and classes may be held in the evening.
I would also like to receive training on other subjects related to the prevention of violence.

Finally, the participants were asked whether they encountered any negative situations during the training. The results regarding this are presented in Figure 2. A significant portion of the participants stated that they did not encounter any negative situations during the training. Some participants did not give any answer to this question. Some of the participants stated that they experienced technical problems during the training, and some stated that each lesson in the training took a long time.
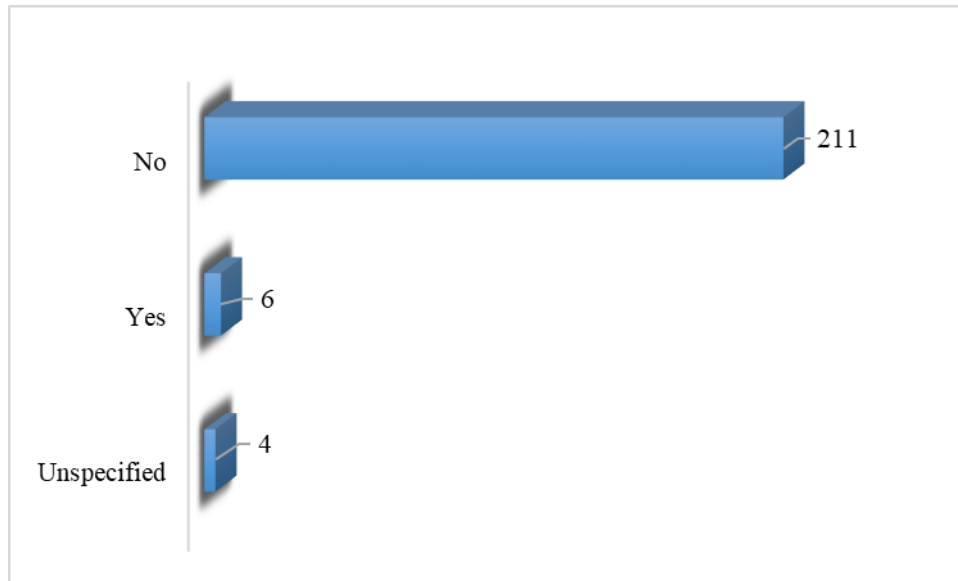
Figure 2. Distribution of Whether They Encountered Any Negative Situations During Training

Conclusion

The research findings indicate a high level of satisfaction among the majority of participants regarding the training curriculum. Participants consistently reported that the training content was valuable, equipping them with essential knowledge and skills relevant to their fields. The overall positive reception suggests that the curriculum was well-designed to meet the learners' needs, providing both theoretical and practical insights that are directly applicable to their professional contexts.

One of the key strengths of the training, as highlighted by participants, was the active encouragement of participation. This participatory approach fostered a dynamic and interactive learning environment, which not only made the sessions more engaging but also enhanced the overall learning experience. The opportunity to interact, ask questions, and discuss topics in depth was particularly appreciated, as it allowed participants to clarify doubts, exchange ideas, and learn from each other's experiences. Such interaction is crucial in adult learning, where peer learning often plays a significant role in reinforcing and contextualizing new information. Furthermore, the belief that the training would contribute to both individual and professional development was a recurring theme in the feedback. Participants expressed confidence that the skills and knowledge acquired would be instrumental in advancing their careers. For many, the training was seen as a steppingstone toward greater competence and confidence in their roles. This perception underscores the importance of continued professional development and lifelong learning, particularly in fields where knowledge is continually evolving.

The positive impact on professional development is particularly noteworthy. Many participants felt that the training not only enhanced their current skill set but also broadened their professional perspectives. They reported gaining a deeper understanding of the subject matter, which they believed would enable them to

perform their job responsibilities more effectively. Additionally, the training was seen as an opportunity for networking and building professional relationships, which can be just as valuable as the content itself in fostering career growth.

Personal development was another significant outcome identified in the research. Participants indicated that the training had a profound effect on their self-confidence and motivation. Acquiring new skills and knowledge gave them a sense of achievement and empowerment, which translated into increased enthusiasm for their work. This is an important finding, as personal development is closely linked to job satisfaction and overall well-being in the workplace. When employees feel confident and capable, they are more likely to be productive and engaged in their roles.

The research also highlighted the importance of training in contributing to a culture of continuous learning within organizations. By offering opportunities for professional development, organizations demonstrate a commitment to their employees' growth, which can lead to higher levels of job satisfaction and retention. Participants noted that their organizations' support for such training initiatives made them feel valued and invested in, which in turn motivated them to contribute more effectively to their teams and projects.

However, it is also important to consider the areas where the training could be improved. While the majority of participants were satisfied with the content, some suggested that the training could benefit from more practical, hands-on exercises. This feedback points to the need for a balance between theoretical knowledge and practical application in professional development programs. Ensuring that participants have the opportunity to apply what they have learned in real-world scenarios can enhance the effectiveness of the training and lead to better outcomes.

Moreover, the feedback suggested that future training sessions could be tailored more closely to the specific needs of different professional groups. While the training was generally well-received, a more customized approach could ensure that the content is even more relevant and impactful for each participant. This could involve offering different modules or tracks within the training program, allowing participants to focus on areas most pertinent to their roles and career goals.

In conclusion, the research clearly demonstrates the value of the training curriculum in fostering both personal and professional development among participants. The high levels of satisfaction reported suggest that the training was successful in meeting its objectives and providing participants with valuable knowledge and skills. The emphasis on participation and interaction was particularly effective in creating a dynamic learning environment, which contributed to the overall positive experience.

Moving forward, incorporating more practical exercises and tailoring the content to specific professional needs could further enhance the impact of the training. Organizations that invest in such development programs are

likely to see significant benefits, including higher employee satisfaction, improved performance, and stronger retention rates. The findings of this research underscore the importance of continuous learning and professional development in today's fast-paced and ever-changing work environment.

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World Health Organization (WHO), World Health Organization Understanding and addressing violence against women: Intimate partner violence, 2012. Retrieved from: http://apps.who.int/iris/bitst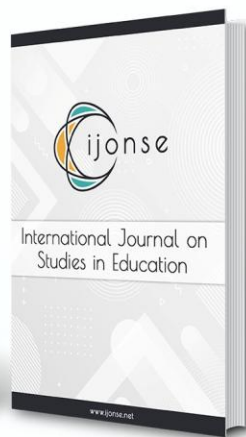ream/10665/77433/1/WHO_RHR_12.35_eng.pdf