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**Research Article**

# Developing Educational Values Among Students Through Stem Activities

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**ABSTRACT**

The main aim of the current study is to develop a suggested proposal to include tenth-grade STEM learning in mathematics lessons. The study followed a qualitative approach based on Braun and Clarke's (2006) method, using an analytical tool consisting of three types that encompass various educational values. These values are distributed as follows: personal values (36% of the total values received during the intervention unit), social values (41% of the total values observed in activities), and cognitive values (23%). Different types of moral values were distributed, with social values being more prominent (16%) in observations from interviews, and cognitive values (18%) exceeding personal values. The integration of topics clearly helped in reviving students' values, but there was a lack of a clear vision regarding the concepts and applications of the STEM teaching strategy. Based on the study results, a proposed vision was constructed, including the foundations, goals, content, activities, mechanisms and strategies for treatment, and methods for value development.

**Keywords:** STEM, Educational Values, Mathematics Education, Personal Values, Social Values, Cognitive Values, Qualitative Research, Value Development, Educational Strategies

## Introduction:

Educational scholars worldwide have varied in their definitions of values. Some consider them as goals or standards to measure individual behavior, while others see them as a set of social philosophical standards acquired by individuals through the community, both explicitly and implicitly. School curricula play an active role in enhancing educational values in learners (Morryssett & Williams, 1982). Values are important as they ultimately affect the behavior of the learner (Raths, 1966; Bishop, 1987; Ernest, 1991).
There are several strategies for expressing mathematics through values. This perspective links students' engagement with mathematics in school to its values. Unfortunately, many students struggle to think about values related to lessons and receive little support and development regarding value concepts in mathematics. Consequently, there is little explicit teaching and discussion of values in mathematics classes (Seah & Bishop, 2003).

One of the primary objectives of methodical education is shaping an individual's moral identity and preparing them to become active members of society. Smith (1997) emphasizes the importance of productive work values, both individually and collectively, in education. Habib (2005) points out that the objectives of education include highlighting the value of work and life skills such as time management and decision-making. There has been increasing interest in teaching mathematics through sciences in recent decades (English, 2012; Kaiser, 2010).

It is noted that the knowledge required by a student extends beyond scientific content to include educational values, beliefs about mathematics, and attitudes toward it. Due to the abstract and deductive nature of mathematics and its hierarchical structure based on logic (Swadener & Soedjadi, 1988), some view it as an abstract science unrelated to values (Bishop, 2002). However, mathematics is rich in value aspects implicit in its structure, which are not seriously considered during educational discussions in mathematics teaching (Clarkson, 2000). Bishop and others (1999) argue that beliefs, attitudes, and values are interconnected and overlapping terms.

## Research Importance:

The current study's significance lies in its development of ethical values through the integration of topics in mathematics lessons using new methods and activities. It also adds to the body of research on ethical value conflicts by addressing student behaviors in response to various situations.

## Research Aim:

The current research aims to develop educational values and associated positive actions among students through their engagement with integrated topics in mathematics and electricity.

## Research Questions:

1. How can values be developed among students through the integration of topics in mathematics lessons?
2. How are educational values demonstrated in the intervention unit integrating topics in mathematics?
3. Is there a relationship between the development of educational values and topic integration?

Theoretical Background

The theoretical background and previous studies are discussed in two main axes: values in mathematics education, and STEM education. The focus is on the hidden curriculum and the integration of theoretical and practical aspects of the mathematics curriculum to achieve effective teaching and learning, with the aim of developing a teaching method where students acquire knowledge and skills through learning mathematics.

### *Values in Mathematics Education Within Schools*

Values are one of the fundamental pillars of education at various stages and hold significant educational importance. Values encompass cognitive, affective, and behavioral components derived from attitudes. They have both personal and social aspects. Seah (2003) asserts that individuals' attitudes and beliefs can change due to human experiences throughout life, especially during adolescence. Another researcher, Dede (2006), mentioned that the source and origin of values lie deep within the human psyche.

Values play a vital role in educational development in mathematics and significantly influence the acquisition of personal and societal identity. Mathematics lessons particularly emphasize values in education due to their impact on students' choices and their confidence in mathematics (Fitzsimmons, 2001). Sam and Ernest (1997) categorized values in mathematics into three domains: cognitive values, which include precision, organization, rationality, and appreciation of knowledge; cultural and societal values, which include the role of mathematics in society and culture; and personal values, which include curiosity, diligence, patience, confidence, and creativity.

### *Concept of Educational Value in Mathematics from Researchers' Perspectives*

Values are a system of psychological predispositions that enable relatively consistent behavior regarding moral, religious, and social situations, despite their complexity (Abdel Hamid Al-Shadhili, 1999). Values represent a code of conduct in society, organizing interactions among individuals who choose to adhere to these norms, knowing the positive outcomes. Various definitions of moral values exist; they align with what is right according to known standards, avoiding errors or sins (Magdy Ismail, 2004). Values are also defined as cognitive awareness and psychological will, manifested in practices and entrenched traditions, such as in mathematics (Fitzsimmons, 2001).

Another perspective defines values as a set of firmly held beliefs, cognitive, affective, and behavioral perceptions chosen freely after deep reflection. They form a system of standards by which individuals judge things as good or bad, acceptable or unacceptable, and consistent behaviors characterized by stability, repetition, and pride (Majid Al-Jallad, 2007). Values are also seen as a system of rules governing interactions and relationships within communities, based on concepts such as trust, justice, and rights (Oladipo, 2009).

Some researchers emphasize values as a set of noble goals derived from the culture and beliefs of society, acquired by individuals through learning and upbringing. These values are deeply held, defended, and used to judge behavior (Kaur, 2015).

### *Educational Values During Mathematics Lessons*

Lakatos (1976) and Polya (1954) identified honesty, humility, and criticism as values distinguishing mathematicians. Ben Yehuda (1962) stated that the goals of value education in mathematics include fostering trust in formal logic theories, appreciation of mathematics, and its contribution to human progress, developing coordination, self-learning, concentration, correct and logical thinking, self-confidence, belief in self-power, responsibility for actions, analysis, control, and clear and precise expression. Paul Ernest (2004) emphasized the importance of developing critical thinking through mathematics as an essential skill for ambitious citizens aiming for social justice in a democratic state. Bishop (2008) distinguished between three sets of values: rational mathematical values, values in teaching mathematics such as precision, and general values like respect for others.

Researchers have described examples of different study topics in post-primary mathematics that they claim allow the integration of value education into verbal problems through context during the teaching process (Kovsmose, 2007; Osler, 2006; Peterson & Gutstein, 1998; Frankenstein, 2001, 1990, 2009; Taplin, 2002). They believe that mathematics education contributes to the growth of an active, critical generation with civic awareness in a democratic society, thanks to the acquisition of quantitative thinking skills and critical discussion of social issues. Some have published examples of problem-solving-based mathematics activities that address social and economic justice issues while developing quantitative and critical thinking.

### *Importance of Value Education*

Teaching values plays a fundamental role in individuals' and groups' lives, making value education a central educational process. Values determine educational philosophies, guiding educational institutions and curricula. Without values, education would turn into chaos. Kaur (2015) noted the importance of values in guiding individual and group behavior, providing a sense of purpose for actions, helping in reaching goals, and serving as a basis for judging others' behavior. Values enable individuals to understand what to expect from others, discern right from wrong, and take responsibility for their actions, leading to a sense of satisfaction.

### *Pros and Cons of Teaching Values in Schools*

Many topics have been discussed regarding how to teach values, considered by some researchers as the ultimate goal of the educational process. However, some reject this notion, fearing indoctrination in schools. They argue that students should only develop critical thinking (Yizhar, 1990; Sheinberg, 1999). Despite this, the goals of the education system are defined in the Education Law (Israeli Knesset, 2000) with specific values. Noddings (1984) and Weiss (2003) emphasized the role of value education in developing awareness and empathy towards others. Aloni believes that value education protects society by ensuring individuals can correctly and timely identify characteristics, striving to prevent ethical lapses.

### *Hidden Curriculum in Value Education*

The hidden curriculum refers to the concepts, attitudes, values, and skills that students acquire outside the formal curriculum, either voluntarily or through informal interaction. Studies have highlighted the importance of the hidden curriculum in primary education and its role in value acquisition. For instance, Cubukce (2012) aimed to reveal the importance of the hidden curriculum in primary schools, while Bayanfar (2013) examined its impact on academic achievement in high school students, concluding that the hidden curriculum positively affected academic achievement. Yousef Zadeh (2014) explored the relationship between the hidden curriculum and life skills among university students, finding a correlation between bureaucratic relationships in educational settings and students' life skills.

## STEM Education

STEM education aims to provide students with an integrated understanding of science, technology, engineering, and mathematics, preparing them to apply this knowledge to solve complex real-world problems. STEM stands for Science, Technology, Engineering, and Mathematics. It involves teaching these subjects in an interconnected manner rather than separately, emphasizing real-life application (Stemnet, 2020).

Hanover Research (2011) defines STEM as an integrative approach aiming to deepen awareness of the four sciences, focusing on their interconnections. The US Department of Education (2010) views STEM programs as primarily supporting or enhancing science and technology education at the educational level. The National STEM Centre in the UK (2015) emphasizes that STEM education is a government priority to train and educate future generations in these four sciences, preparing them to be capable citizens in a technologically advanced society.

### *Teaching STEM in Mathematics Lessons*

The Professional Teaching Standards by the National Council of Teachers of Mathematics (NCTM) stress the importance of various teaching methods in presenting mathematical concepts and procedures (NCTM, 1991). STEM subjects receive global attention, linking critical thinking skills and problem-solving essential for economic success and competitiveness (Breiner & Koehler, 2012; English, 2017; White, 2014). Research helps understand how to develop STEM students. The STEM program supports educational pathways that meet the needs of diverse students capable of STEM fields (Lent, 2018).

Fouad and Santana (2017) reviewed the social cognitive career theory (SCCT) as a framework for examining disparities among STEM students, showing that SCCT is a stable indicator for STEM career choice across various variables. La and Robbins (2016) tracked a large group of middle school students through high school and college, finding that motivation and ability, driven by environmental factors, were strong predictors of STEM achievement.

### *The Current Reality of STEM Integration*

The current application of integrated STEM education in schools lacks support and focus on modern approaches to teaching and learning mathematics. The need to evaluate the current situation and highlight its importance is evident, especially given the long-standing need for curriculum integration. Integrating and linking subjects to achieve various goals is necessary (Alasdair, Khashan, 2004).

### Concept of STEM in Mathematics Lessons for Teachers

STEM education aims to examine students' understanding of science, technology, engineering, and mathematics subjects, enhancing their ability to apply this knowledge to solve real-life problems. STEM is an acronym for Science, Technology, Engineering, and Mathematics, taught in an integrated manner rather than separately, emphasizing practical application (Stemnet, 2020). Hanover Research (2011) describes STEM as an integrative approach aiming to spread deep awareness of these sciences, emphasizing their interconnections. The US Department of Education (2010) views STEM programs as primarily supporting or enhancing STEM education at the educational level, distinguishing between integration and support.

The National STEM Centre in the UK (2015) emphasizes the strategy of demonstrating the integration and connection between these sciences in real life. Maryland's educational institution in the US describes STEM as an approach to teaching through integrated content and skills in activities to achieve creativity in the four subject areas, preparing students for post-secondary education and meeting the 21st-century workforce needs (Marquart, Taru, Dwyer, 2012).

### *Importance of STEM in Learning Mathematics*

Integrating science, technology, and society results from the reciprocal relationship between them. Science embodies human knowledge, technology applies this knowledge, and society is where these changes occur. The connection between them is strong and reciprocal, as science influences human progress and societal advancement, while technology and society drive scientific movement and knowledge integration (Eliezer, 2011). The National STEM Centre in the UK (2015) emphasizes the importance of this type of education as a government priority to train and educate future generations in these four sciences.

There is a pressing need to change teaching methods to integrate various sciences, especially mathematics. Mathematics is a key fundamental subject, known as the gateway to social sciences, education, and literature. With the rapid development in various fields, different knowledge areas have become interconnected, making it difficult to isolate any branch of science from others, thus reinforcing the concept of integrating different subjects (Muralidharan, 2009).

One of the main standards of mathematics set by the NCTM is the connection standard, which emphasizes the importance of linking mathematics to the real world and other knowledge fields. The standard states that mathematics learners play a significant role in arts, sciences, social studies, and other sciences, requiring continuous exploration of mathematics applications in real life (NCTM, 2000). When learners use mathematics in other subjects, they perceive it differently, making it more meaningful and beneficial, enhancing their understanding.

### *STEM Integration in Mathematics Education*

The current application of integrated STEM education in schools lacks support and focus on modern approaches to teaching and learning mathematics. The need to evaluate the current situation and highlight its importance is evident, especially given the long-standing need for curriculum integration. Integrating and linking subjects to achieve various goals is necessary (Alasdair, Khashan, 2004). Early exposure to STEM interests may increase the number of students pursuing STEM-related college degrees (Maltese & Tai, 2011). Informal learning experiences, such as values and principles, can positively support students' attitudes (Ozis et al., 2018), specifically through participation in STEM intervention programs.

## Research Methodology

### Type of Research

This study adopts a qualitative research approach, a type of scientific research that relies on studying behavior and ethical attitudes. Information and data are gathered through various means such as interviews and observations. This approach was chosen to provide comprehensive explanations of the research topic, resulting in descriptive statements suitable for the study's objectives. These objectives include identifying the values that appear in tenth-grade mathematics classes when students learn in an integrated subject environment, analyzing information, and attempting to understand the importance of values in mathematics and students' reactions when questioned about them.

### Research Population and Sample

The research was conducted in an Arab secondary school in the southern region of the country, with approximately 1600 students, 75% of whom belong to one family. The school has seven grades from seventh to thirteenth. The selected sample includes a tenth-grade class specializing in electricity and another tenth-grade class specializing in physics. Most students are prepared to take four units in five core subjects

(Mathematics, Arabic, English, Electricity, Hebrew). The sample consists of 34 students: 22 boys and 12 girls. According to the school's administration, the students' behavior is generally acceptable.

### Research Tools

- **Observations:** The study primarily relied on audio-recorded observations of the sample during three tasks conducted in mathematics classes.
- **Interviews:** The interviews included several questions about the lesson, divided into three axes related to the ethical values of each task. These interviews aimed to understand how students were affected by events and objects around them, why they reacted the way they did, and how opinions and attitudes formed. The interviews were direct and recorded, and individual interviews were conducted.

### Research Procedure

The research was conducted in several stages:

1. **First Stage:** The activity on the topic of resistors was explained before conducting the experiment, and students' reactions were recorded and analyzed.
2. **Second Stage:** The intervention unit was implemented practically in the laboratory by the researcher, focusing on resistors and recording observations.
3. **Third Stage:** The researcher discussed students' opinions.

The same stages were applied in three different lessons with various topics. Initially, three activities integrating science and mathematics on the topic of electrical energy and functions were designed according to the STEM integrated curriculum. These activities aimed to evoke values and were planned to be conducted outside the classroom. However, due to the COVID-19 pandemic and school closures, the activities were adapted for remote learning using technological tools. With the help of a supervisor, the Edraw Max tool was selected, and a simulation program for electrical circuits was used to enhance inquiry and understanding. Questions were developed to align with the components and the STEM curriculum.

### Intervention Unit

Three activities were conducted over three sessions as follows:

1. **First Session:** The first activity focused on the topic of functions and the effect of parallel consumer installation on power current ratio.
2. **Second Session:** The second activity dealt with functions and the effect of series consumer installation on power current ratio.
3. **Third Session:** The third activity addressed the topic of functions and transformer installation.

The activities were documented through recordings and notes for data analysis. The STEM curriculum was used by integrating science and mathematics for tenth grade, focusing on functions and power current ratio through individual and group activities. The topics included:

1. The effect of parallel resistor installation.
2. The effect of series resistor installation.
3. The effect of random resistor installation.

Due to the COVID-19 pandemic, activities were adapted for remote learning using the Edraw Max tool and a computer-based electrical circuit simulation program. The program enhanced inquiry and understanding, and questions were developed to align with the components and the integrated curriculum.

### Values Table in Activities

| Activity | Educational Value | Explanation of Value in Activity |
|---|---|---|
| First | Orderliness | The experiment requires the student to recognize that the arrangement of the circuit affects the outcome. |
| First | Economical Efficiency | Less effort is required with a parallel circuit arrangement. |
| Second | Equality | Input energy equals output in a transformer. |
| Second | Balance | The transformer maintains balance in the circuit. |
| Third | Environmental Preservation | Green energy. |
| Third | Efficiency | Maximizing the use of solar energy. |

## Data Analysis

- **Observations:** Data analysis was based on the classification by Sam and Ernest (1997), as follows:

1. **Cognitive Values:** Related to acquisition, evaluation, and mathematical cognitive characteristics, including precision, methodology, and rationality.
2. **Social Values:** Supporting the social group or community, related to individual duty towards society in mathematics education, including cooperation, justice, and appreciation of mathematics.
3. **Personal Values:** Affecting the individual as a learner, including patience, confidence, and creativity.

Despite being an older classification, Sam and Ernest's framework was chosen for its clear division into cognitive, social, and personal values. Videos were transcribed by noting the line number, person, and text.

- **Event Analysis:** At the beginning of the event, students showed signs of surprise, confusion, and anxiety, indicating a discrepancy between individuals and the technological tool. This discrepancy gradually

diminished, leading to increased student interaction and engagement, with signs of happiness and positivity as students competed to solve problems and expressed satisfaction with their answers. This change was evident in their relaxed posture compared to their initial nervousness.
In Event 1, personal responsibility was demonstrated by Shaher, who took on the role of group leader, indicating a social value of cooperation. Ibrahim exhibited a cognitive value of competence by proposing a scientific hypothesis, demonstrating the link between cognitive and social values. Other students also showed cooperation, further emphasizing social values.

- **Interviews:** The data from the interviews were analyzed qualitatively based on Braun and Clarke's (2006) method to identify the core content, ignoring irrelevant subtopics. The focus was on how students connected topics and maintained narrative consistency.
- **Data Analysis:** Teacher's questions were designed to stimulate and guide students towards the correct solution. Initially, students relied on prior knowledge, indicating social values like economical efficiency and cognitive values like planning. The teacher's role was to direct students towards other values. Unexpected student discoveries highlighted personal values like creativity. Interviews revealed that mathematics and electricity help express values practically and scientifically, drawing students' and teachers' interest and facilitating discussions on various values.

The findings indicated a balance between cognitive, social, and personal values, with some values appearing directly and others indirectly.

## Results

In the results, we will address the features that enhanced values in the activities the student went through, the values encountered during their interaction with activities involving subject integration, and the development of educational values throughout these stages. In the first stage, we will present the results of educational ethical values in the two groups during the activities. In the second stage, we will show the links of educational values during the activities between the two groups. In the third stage, we will present the results of the analysis of interviews with five students and how values (personal, social, and cognitive) were reinforced, mentioning the recurring factors that enhanced educational values among the students. We will also highlight examples from interviews with participants in the development of values resulting from the activities and discuss ideas that foster educational values in the lesson.

### Educational Values During Activities (Linking Values and Results)

The results show that various types of values were reinforced within the integration of subjects and mathematics. Several educational values emerged during the teaching of the intervention unit, including personal, cognitive, and social values. The intervention unit helped present various values and create tools for cooperation in building concepts and educational values, representing mathematical problems, and using technology in teaching mathematics. The results confirm the importance of using technology in processing mathematical ideas through ethical values in mathematics teaching, emphasizing discovery learning and solving mathematical problems.

### Social Value

From the results and data shown in the observations, the proportion of words indicating social values is 42% of the total values. The integration of subjects developed social and intellectual connections among students as they experienced a tangible mathematical representation of reality, showing a direct relationship between learning mathematics and electricity. The students' practices during the laboratory experiment and their active participation in the classroom enhanced the social value, which ranked first among the three values (cognitive, social, personal).

**Example from Group 1:**

- **Student: Mohammed**
  - **Dialogue:**
    - *Mohammed: "Alright, let's try and help each other. It seems really fun!"*
    - Here, through the answer and implementation, the student showed cooperation and enthusiasm for experimenting with the program. The social value is reflected in the phrase "let's help each other" (line 2), encouraging classmates to ask each other questions, thereby fostering a trusting environment within the group.

**Example from Group 2:**

- **Dialogue:**
  - *Aden: "Teacher, what power source should we choose?"*
  - *Samia: "The teacher said to compare series and parallel. So choose 5 volts."*
  - *Teacher: "Correct, the entire class should use the same parameters as the previous task. Let's complete the experiment."*
  - *Aden: "I'm ready, I've finished and even wrote multiple equations."*
  - *Mohammed: "Yes, teacher, the equations increased."*

In lines 18 and 19, each group member was willing to help with what they had achieved. Aden asked about the unknown voltage, and Samia responded (line 19), linking the previous lesson to the current one and helping Aden solve the problem. Aden looked at the teacher for confirmation of the answer. In line 23, Mohammed began to understand what the group members had achieved, increasing the number of equations and participating in answering in good faith, thus reinforcing the educational value of trust and support.
In both groups, cooperation was evident as they began thinking and searching for explanations and justifications for their findings. One group started giving examples to test the accuracy of their findings by using the current law they had previously learned. The other group identified the answers by completing the experiment and comparing the results through calculations to verify the accuracy. After seeing the correct answer, the group worked together to interpret their findings, thereby developing their social values.

### Summary of Social Value Analysis:

The educational social value was evident 243 times across all activities, accounting for 42% of the total educational values observed. The social values appeared 98 times in the interviews, indicating that the social value was most prevalent during group work.

### Cognitive Values

From the analysis of the interviews and observations, cognitive values hold significant importance. For instance, the value of knowledge "saving" appeared, making up 23% of all values. Cognitive values were derived from words indicating knowledge of the subject, demonstrating the students' interest in knowledge through their questions during activities. Cognitive values frequently emerged during the intervention unit and were directly evident during math lessons and subject integration.

**Example from Group 1:**

- **Student: Shahir**
  - **Dialogue:**
    - *Shahir: "There are three electric circuits, and each time we try a different shape."*
    - *Shahir: "The direction of the current is upwards, just like a vector with a specific direction and magnitude. If the current is upward, they have the same direction?"*
    - *Shahir: "In V = V1 + V2 + V3, if we substitute, V is equal to...?"*

Shahir demonstrated cognitive educational values by explaining the direction of the current (line 26), balancing between mathematical and physical (electrical) knowledge. It's challenging to separate mathematics from other subjects. The researcher noted that some students understood the mathematical structure and relationships, giving meaning to the mathematical procedures related to electricity and understanding the connections between mathematical concepts.

**Example from Group 2:**

- **Dialogue:**
  - *Aden: "I'm ready, I've finished and wrote multiple equations."*
  - *Mohammed: "Yes, teacher, the equations increased."*
  - *Teacher: "Correct, why?"*
  - *Mohammed: "Because each resistor has its own current."*
  - *Samia: "Each resistor is connected separately, not together."*

In this phase, some students successfully completed the task, showing that there were multiple equations. Aden stated (line 21) that they finished and wrote multiple equations, indicating the correct solution and writing the equations accurately. Mohammed (line 23) also reached the correct equation. The teacher asked "why" (line 24) to reinforce cognitive self-discovery through research and exploration.

### Summary of Cognitive Value Analysis:

There were 195 words indicating cognitive educational values across all activities, representing 24% of the total educational values observed.

### Personal Values

From the analysis of observations, personal educational values have an important place in the development of lessons integrating subjects. The results showed that personal values accounted for 36% of the total educational values observed. These values increased among students through the characteristics related to circuit components. Personal educational values were clearly present when the intervention unit was applied in mathematics and subject integration, ranking second among the three values.

**Example from Group 1:**

- **Student: Salem**
  - **Dialogue:**
    - *Salem: "For the resistance hypothesis, I think we should calculate and write, then use the program."*
    - Value of rationality and honesty: Calm tone in answering, logical and rational response.
    - Shahir: "People work with electricity and consume it without thinking if they can change or install things differently. There's a risk from lack of understanding and dangerous electrical experiences."*

Salem demonstrated the value of rationality by suggesting logical and rational actions (line 6). Shahir highlighted a personal value by linking the topic to daily life, emphasizing the need for responsibility and careful calculations in electrical work (line 10).

**Example from Group 2:**

- **Dialogue:**
  - *Samia: "First, I'll install the transformer, then the consumer, and finally connect the power source. What do you think?"*
  - *Aden: "Okay, I'll write the answer and compare it to yesterday's lesson."*
  - *Samia: "It should yield the same results."*
  - *Samia: "We can plan and create an electric circuit accurately."*
  - *Aden: "I also understood why we learned the equations and their purpose."*

The integration of subjects fostered personal values in students. Samia (line 40) tackled functions in a way that enhanced the value of order and organization. Aden (line 41) reinforced the value of comparison and analysis. Samia (line 58) demonstrated planning and self-confidence, while Aden (line 59) showed understanding and linking topics.

### Summary of Personal Value Analysis:

Personal educational values were evident in 81 words from the interviews and 277 words from the observations, accounting for 36% of the total educational values observed.

### Interview Analysis Results

The researcher used interviews to support the findings from observations over six lessons for two groups, allowing for precise results. Five students were randomly selected from both groups for interviews. During the interviews, additional questions were asked to obtain more detailed information. The interviews revealed various educational values, showing that the students had a new and different experience. The tools and resources enabled them to develop their professional skills and educational values, which were reinforced through feedback from students and analysis of interview results.

### Factors Enhancing Educational Values in Activities

Analysis of the interviews highlighted factors that reinforced educational values at the personal level, essential for societal development and improving relationships among individuals. The researcher identified ethical values that were enhanced in mathematics lessons, such as respect, saving, communication, freedom, and order.

### Respect Value

A common factor in the interviews was respect, one of the essential qualities a teacher should foster. Respect benefits public interest and motivates students to behave respectfully towards various entities. Students naturally gravitate towards rebellion, and teachers must channel this trait positively by engaging students in non-traditional tasks with incentives for discovery or encouragement. The results showed positive behavior from the students.

**Example:**

- **Dialogue:**
  - *Teacher: "Did you finish the task?"*
  - *Aden: "Yes, of course. I executed what the teacher asked for."*
  - *Teacher: "I see you smiling?"*
  - *Ibrahim: "Yes, it's my first interview like this."*
  - *Teacher: "Where did you see this information?"*
  - *Salem: "In all the lessons, they all include math."*
  - *Mohammed: "Order, organization, respect."*

Aden's response (line 38) clearly showed respect and obedience to the teacher by completing the task. Ibrahim (line 4) displayed positive behavior and a smile, indicating respect for the teacher. Salem (line 42) emphasized the importance of respecting the subject of mathematics, highlighting respect for people, the subject, and self-respect.

### Saving Value

The saving value in the intervention unit focused on training and developing students' skills in saving electricity through correct planning. This value was reinforced through the experiment, helping students understand the importance of saving, especially with simple mathematical operations. Saving is a common trait across all societal groups.

**Example:**

- **Dialogue:**
  - *Shahir: "The problem is in consumption, electrical consumption affects many things."*
  - *Mohammed: "Calculating electricity correctly helps us use it better."*
  - *Aden: "With correct calculations, you can save on materials and efficiency."*

- *Salem: "I mean, assembling the circuit better and with less effort."*
- *Ibrahim: "We could achieve better results with the same tools, saving energy and work."*

The common factor among students was the reinforced value of saving electricity through mathematical equations for calculating energy and assembling it correctly. Shahir (line 8) recognized the importance of saving through mathematics and correct calculations. Mohammed (line 14) acknowledged that accurate calculations lead to better utilization. Aden (line 24) expanded on saving, advising on saving materials and efficiency in circuit assembly. Salem (line 20) discussed saving indirectly, explaining that accurate calculations help assemble better circuits with maximum efficiency. Ibrahim (line 26) emphasized saving through the correct use of tools.

### Freedom Value

Freedom is a crucial aspect of life, and this value was common among both groups. Freedom is fundamental for the progress of nations and relies on knowledge and experience. Students, as the primary output of schools, need intellectual, moral, and organizational components based on the value of freedom in choice, as seen in students planning the suitable electrical circuit.

**Example:**

- **Dialogue:**
  - *Shahir: "We can achieve the same goals while saving half the money if we work correctly."*
  - *Mohammed: "There are many possibilities and choices."*
  - *Aden: "We benefit a lot from knowing how to plan circuits correctly."*
  - *Salem: "It's essential to plan correctly for efficiency."*
  - *Ibrahim: "Understanding the requirements helps in planning better."*

The dialogue clearly demonstrates the value of freedom in planning and trying different approaches. Shahir (line 22) highlighted the freedom to modify for better outcomes. Mohammed (line 26) indicated multiple possibilities and freedom of choice. Aden (line 14) emphasized the importance of planning, reinforcing freedom. Salem (line 26) underlined the necessity of planning and freedom in choice for success and efficiency. Ibrahim (line 14) discussed the need for freedom and its conditions for successful planning.

### Communication Value

Social communication is one of the oldest and most vital practices that deepen the concept of sharing and connecting with others. This value was common among students. Social communication stimulates creative thinking and learning through different modes, promoting acceptance of conflicting issues and enhancing skills.

**Example:**

- **Dialogue:**
  - *Shahir: "Organization and order are crucial, helping in many things."*
  - *Mohammed: "Equality in power distribution from the source is essential."*
  - *Aden: "It regulates the current according to the consumer, preventing electrical hazards."*
  - *Salem: "The transformer is like the head of the family, facilitating communication."*
  - *Ibrahim: "It acts as a mediator, increasing current or voltage."*

Shahir (line 40) described the transformer's function within the electrical circuit, emphasizing organization and order. Mohammed (line 34) explained the relationship between the transformer's input and output, highlighting communication. Aden (line 36) likened the transformer to a bridge, emphasizing communication. Salem (line 26) referred to the transformer as a mediator, enhancing communication. Ibrahim (line 34) emphasized the transformer's role as a mediator, reinforcing the social value of communication.

### Order (Organization) Value

The analysis of interviews showed the common factor of order and organization, essential for successful individuals and societies. Order and organization build self-confidence and enable the acquisition of social skills like problem-solving and effective management of time and resources.

**Example:**

- **Dialogue:**
  - *Salem: "First, order, then correct calculations, saving in the process."*
  - *Ibrahim: "Knowing the requirements first helps in planning better."*
  - *Aden: "Order and organization are crucial."*
  - *Teacher: "Can you explain the relationship between order and circuit calculations?"*
  - *Shahir: "Order is important for calculations and electrical safety."*
  - *Teacher: "What value does series represent to you?"*
  - *Mohammed: "Order, organization, respect."*

Salem (line 38) emphasized the importance of order and its effect on calculations. Ibrahim (line 14) supported the idea, saying knowing the requirements helps in better planning. Aden (line 38) added that

order improves the circuit's aesthetics and calculations. Mohammed reinforced the value of order and organization.

### Interviews with Students

### Interview with Shahir:

The researcher aimed to understand the depth of the differences and similarities between subjects and how to develop high-level thinking, integrating educational ethical values. Shahir was engaged in the activity, making it more realistic and experienced, directly affecting values. The interview questions encouraged the student to enhance the quality of thinking about values.

**Example:**

- **Dialogue:**
  - *Shahir: "People work with electricity without thinking if they can change or install things differently, posing risks from lack of understanding."*
  - *Teacher: "So, who should be responsible?"*
  - *Shahir: "It doesn't matter who, they need to be educated and responsible, ensuring everything is installed correctly."*
  - *Teacher: "What's the connection between responsibility and electricity?"*
  - *Shahir: "Those working with electricity must be responsible, calculating accurately and installing systems correctly."*
  - *Teacher: "What values did you learn from the experiments?"*
  - *Shahir: "The most important things I learned are saving electricity and safety."*

The student expanded their thinking scope, developing ethical values by comparing and determining the correct approach. Shahir's responses indicated an understanding of various values, such as efficiency, monitoring, and continuous improvement.

### Interview with Mohammed:

The ethical values embedded in the intervention unit were suitable for students' abilities, and the methods used effectively reinforced those values. The highest aspect of values was social, showing a connection between different values and enhancing the comprehensive educational framework.

**Example:**

- **Dialogue:**
  - *Mohammed: "Many things make work easier, reducing effort."*
  - *Teacher: "If you were to translate that into principles or values, what would it be?"*
  - *Mohammed: "Calculating correctly saves effort and resources."*
  - *Teacher: "What components of the electrical circuit do you understand?"*
  - *Mohammed: "Putting everything in its place helps us benefit, like giving the baker his dough."*
  - *Teacher: "What caught your attention the most?"*
  - *Mohammed: "Changing the circuit's arrangement changes the calculations completely, and with the same components, you can create different things."*

Mohammed indicated multiple values, including personal values, by making informed decisions. The cognitive value appeared when Mohammed mentioned "calculating correctly" (line 20), and the social value of saving was highlighted (line 22).

### Interview with Aden:

The interview with Aden showed the reinforcement of multiple values through activities, including saving, order, and understanding educational standards. The activities encouraged positive attitudes and respect for others' opinions, cooperation, and communication.

**Example:**

- **Dialogue:**
  - *Aden: "You can try different ways if something doesn't work."*
  - *Teacher: "What role does the transformer play in the circuit?"*
  - *Aden: "It regulates the current, preventing electrical hazards, acting like a bridge."*
  - *Teacher: "What lesson do we learn from the transformer's role?"*
  - *Aden: "Order and organization are important."*
  - *Teacher: "How did this benefit your daily life?"*
  - *Aden: "Planning before work, setting clear goals, and understanding the problem you're solving."*

Aden demonstrated persistence in solving problems, trying different approaches, reinforcing personal values (line 32). The activities enhanced confidence, understanding, and linking topics.

### Interview with Salem:

Focusing on educational values in school fosters desirable traits like objectivity and fairness. Educational skills help students accumulate useful values, making them positive societal elements. Mathematics and subject integration aid in creating a better future society.

**Example:**

- **Dialogue:**

- *Teacher: "What did you find interesting?"*
- *Salem: "Time passed quickly."*
- *Teacher: "Is that all?"*
- *Salem: "No, we learned a lot."*
- *Teacher: "What differed from other lessons?"*
- *Salem: "There was no central topic, various things."*
- *Teacher: "Was that good?"*
- *Salem: "Yes, the lesson was engaging, and the work was collaborative."*

Salem noted that the lesson passed quickly (line 5), indicating enjoyment and focus. The lesson's content covered multiple subjects, fostering cognitive values. The collaborative work enhanced social values, engaging students in group activities.

### Interview with Ibrahim:

The interview with Ibrahim highlighted value reinforcement through engagement in tasks, showing progress and competence. Understanding the questions and participating actively demonstrated the development of integrated knowledge and life values.

**Example:**

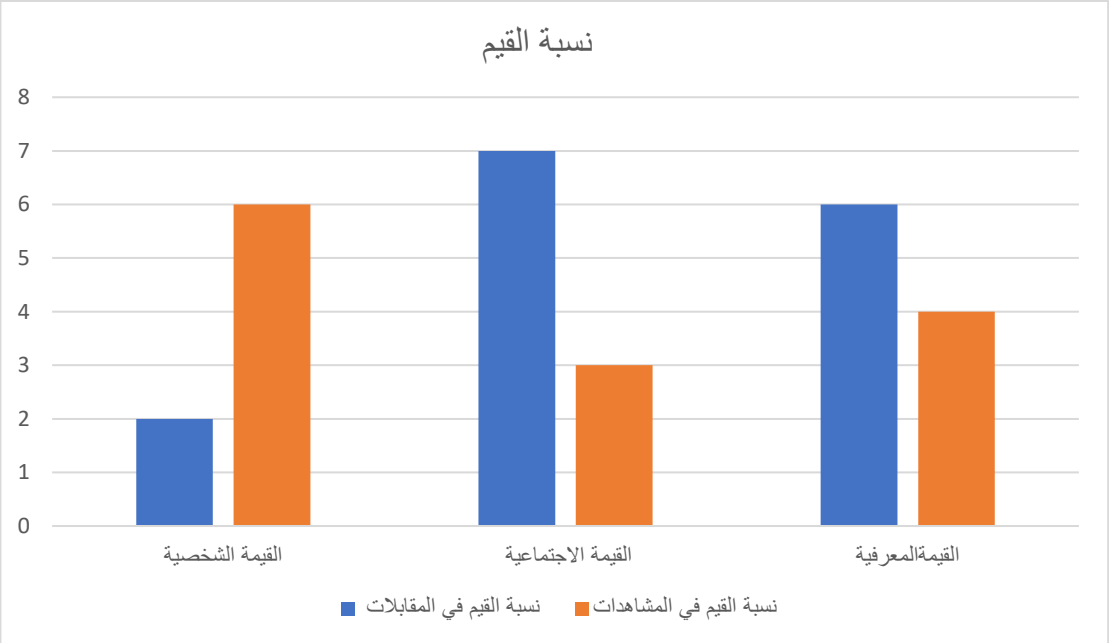
- **Dialogue:**

- *Ibrahim: "The transformer balances the energy source and the consumer."*
- *Teacher: "What do you mean by balance?"*
- *Ibrahim: "It acts as a mediator, increasing current or voltage."*
- *Teacher: "How do you see this in life?"*
- *Ibrahim: "Like a mediator in solving problems."*

Ibrahim understood the transformer's function (line 32), enhancing cognitive and personal values. The intervention unit reinforced social values by understanding the transformer's mediation role (line 34).

## Summary of Results in Numbers

In this phase, we found the relationship between all words in the observations and the number of words reinforcing social, cognitive, and personal values. A graph was created to depict the percentage of each value from the total. 8354 words were analyzed, with 2238 from interviews and 6116 from observations. In the interviews, 81 words reinforced personal values, 57 cognitive values, and 125 social values. In the observations, 277 words reinforced personal values, 184 cognitive values, and 195 social values. The graph shows the percentage of values from the total words in the intervention unit, comparing the values with each other.




## Discussion

### Overview of the Study

This study aimed to examine the ethical values and accompanying principles that students exhibit while engaging with mathematical tasks that integrate technology to overcome physical challenges in the field of electricity. The data were analyzed based on the classification theory by Sam & Ernest (1997), which was tracked by the teacher during and after the activity. In the second phase, student interviews and their responses during the educational activities were analyzed based on Braun and Clarke's methodology.

### How Values Are Developed in Students Through Integrated Subjects in Mathematics Lessons

The question of how values are developed in students through this research is significant. The study found that the levels and types of ethical values presented in the lesson were influenced by the lesson's content and format. Practical lessons and group learning activities showed different levels of ethical values compared to theoretical or individualized lessons. The analysis indicated a strong relationship between the lesson format and value development. The social value emerged as the most prominent, likely due to the interactive and discussion-based format of the lesson, which involved the integration of various subjects, especially the connection between electricity and mathematics.

### How Educational Values Emerge During the Intervention Unit of Integrated Subjects in Mathematics Lessons

The findings emphasize the importance of integrating ethical values into educational content. The integration of these values into mathematics activities helps to mitigate the rigidity of mathematical subjects, focusing not only on scientific aspects but also on aesthetic and recreational elements. This interdisciplinary approach, involving subjects like physics, can significantly enhance students' interest in mathematics, as supported by previous studies (Moody, 2010; Piaget, 1985; סגליס, 2008).

### Relationship Between Developing Ethical Values and Integrating Subjects

The results suggest a moderate to good relationship between ethical values and subject integration, with approximately 7% indicating value development. This aligns with English's (2012) findings, attributing the result to diverse knowledge sources beyond traditional teacher-led instruction, such as technology, electricity, and self-directed learning. The study highlights that integrated subjects can enrich students' understanding and values.

### Student Engagement in Activities

Students showed positive engagement in activities involving integrated subjects and values in mathematics. The researcher's efforts to apply integrated subjects clearly demonstrated that such an approach enhances ethical values, particularly through practical and discussion-based segments. Personal value development was notably fostered through dialogue, underscoring the importance of integrating subjects to enhance ethical values. This comprehensive approach increases knowledge and interaction, as supported by Bastas (2019).

### Content and Impact of the Intervention Unit on Students

Analysis of the data revealed that students were required to explain and evaluate lessons both orally and in writing. The researcher determined the impact of the intervention unit on ethical value development at various levels. The active student participation in the intervention unit aligned with the hypothesis that integrated subjects foster value development. Documenting activities through recording and note-taking highlighted the significant presence of ethical values. The use of the STEM (Science, Technology, Engineering, and Mathematics) methodology, which blends science and mathematics, proved beneficial for students, covering topics like functions and electrical efficiency.

### Benefits of Teaching Mathematics Through Integrated Subjects

This study underscores the advantages of teaching mathematics through integrated subjects using the STEM approach. This method provided new insights within educational research, demonstrating how integrating subjects can make complex topics more accessible. It addressed challenges in handling technology, particularly in electricity, an often challenging subject for students. Students applied their learning in various contexts, validating the effectiveness of the approach (Merenluoto, 2005).

### Importance of Teaching Values in Integrated Subjects from the Teacher's Perspective

The results showed that ethical values were prominently featured in approximately 12% of the intervention units, emphasizing the importance of integrating these values across all educational stages. Teachers play a crucial role in instilling these values in mathematics lessons. The findings reflect the high level of attention from mathematics teachers, highlighting the necessity of incorporating all educational values in mathematics lessons. This aligns with previous studies (Breiner & Koehler, 2012; English, 2017; White, 2014) that stress the need for a comprehensive list of educational values to be included in the curriculum at all educational levels.

## Recommendations

In light of the study's results, the researcher recommends the following:

1. Focus on providing training courses for high school students to enhance their learning skills.
2. The necessity of including programs and activities that employ the STEM strategy.
3. Conduct more studies on values using the STEM strategy, especially targeting high school students, and other educational stages or groups.
4. Integration of subjects helps students in mathematics to understand both mathematics and physics effectively, achieving "two birds with one stone."
5. Ethical educational values are an essential part of teaching mathematics and science.

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