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Integrating Technology into Mathematics Education Using Impact Diagrams and Decision Trees

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Abstract

The aim of this paper is to answer the following questions: What is meant by models of decision analysis, philosophy, and components? What is the role of decision models in analyzing the decision problem to reach the expected value? What is the logical relationship between the two models of decision analysis: the influence diagram, the decision tree, in solving the decision problem? In order to answer the research questions, the steps for building an influence diagram and how to draw it, as well as steps for building a decision tree and how to draw it, were presented. This research also clarified how to turn the tree back and reach the best option using the expected financial value base, and the importance of the role of sensitivity analysis in choosing assumptions and structured alternatives in decision analysis as one of the many advantages of using typical decision analysis in decision-making and decision-making. Based on decision analysis and the use of the two models, the best option is to have a math lab with an expert and pay eight thousand dollars, and to achieve material value (conceptual structures, facts and skills) and moral value (appreciation and respect). And use the evaluation process by conducting achievement tests. Refer to studies and research that address controversial issues of the use of the Mathematics and Computer Laboratory in education.

Keywords: decision, decision analysis, influence diagram, decision tree, 3D pen, interactive whiteboard, math lab, achievement.

Introduction:

The interest in educational technology has increased recently due to the great role it plays in the various fields of the educational process, including devices, tools, materials, educational situations and teaching methods. It also relieves time constraints in school activities and maintains the state of communication between the teacher and the learner (Al-Hela, 2002).

In addition, technology is not just the application of scientific or cognitive discoveries to produce certain tools or perform certain tasks to solve human problems and control the environment, but in addition to that, it is a process that expands to include the social conditions that have produced them. It also includes the various aspects of social behavior when applied, and hence the technology could not claim innocence, which may result in social changes when applied (Madkour, 2002).

So as Decision takings to introduce technology in education, especially mathematics education, must simultaneously provide a value curriculum taught to students to ensure that they are provided with values and raise academic achievement. They must also strive to create a heterogeneous environment within the school in order to reduce the differences between students (Zaher, 2004).

And Proceeding from the fact that students are the citizens of the future and they feel comfortable with modern technology and acquire skills to use them easily. Hence, decision takings must bear in mind the necessity of making appropriate decisions to introduce the appropriate type of technology tools.

The planning to project decision problem:

In the age of technology, the Ministry of Education decided to provide all schools with an amount of money to help them teach mathematics with two valuable solutions (both material and moral). The director of the East Jerusalem School District gathered a working group made up of mathematics inspectors, experts, experts and specialists (the responsible for the accounting department in the municipality, a technology and software, ...) and presented them with the aim . What is required is to build an impact plan to clarify the best path to achieve the value desired by the ministry (material value: conceptual structures, facts and skills, and moral value: appreciation and respect). The school principal (decision taking) clarifies and explains the aim , and grants an amount of money to obtain material and moral value for the work team, experts and specialists. It is required to take a decision analysis of the problem / aim to be achieved.

The problem of the decision, and his questions:

The researcher stopped several studies that focused first: E-learning in Palestine and the strategic plans for developing teaching skills in secondary schools, the response to education between teachers and students in programs and projects supporting programs and their suitability with academic reality (Al-Jayousi, 2015). University education that thrives in school education (Wang, et al, 2014) Higher education, change and development, and the digital message that affected school education and the Internet (Wang, et al, 2014) were noted in the modern era and based on diversifying the educational process and seeking the best features that emerged To help in obtaining good teaching aids, the teacher and the student have access to more information and at a lower cost (Kennedy &Giampetro, 2015).Second: Studies focused on the use of schema and decision trees in decision-making, such as the study of (Yuh-jynHn, 2011), and (Mampreet, 2007) in the possibility of the bankruptcy of companies and many others. Given the weak use of modern technologies for mathematics classes because they are general topics and curiosity and action, and based on the decision issued by the Ministry of Education in 2018 to set the budget for the implementation of education in schools, it is hoped that It becomes hoped that this educational opportunity to advance students, increase their achievement in the subject of mathematics, and enrich them with noble and sapphire values, in a way that suits their different aptitudes and abilities. Sometimes you may find it, either their faith is in answering the following questions:

The Ffirst Question: What are Decision Analysis Models, Philosophy, and Components?

Second question: What is the role of decision models in analyzing the decision problem to reach the expected value?

Third question: What is the logical relationship between the two models of decision analysis: and the influence diagram, the decision tree, in solving the decision problem?

Expected value: The value desired by the ministry (material value: conceptual structures, skills and facts, and moral value: appreciation and respect).

Research aims and objectives:

The main objective in following the scientific method in decision-making and taking it is to try to reach the best possible alternative within the framework of the information available to the taking and the decision-taking, whether he is an individual or a group of individuals. The decision is two models of decision analysis (impact diagram and decision tree), and the researcher believes that the objectives of this current research are as follows:

1- A proposed instructional design for learning in mathematics to improve students' involvement in classroom activities.

2- Helping decision takings to know the available options and alternatives and their fragmentation to reach the decision.

3- Presenting the steps to reach the best alternative in light of the information available to the decision taking and taking.

Importance of Draft Decision Problem:

The research is a scientific effort and with correct scientific tools, and it gains its importance from its topic because it is recent and has not been previously studied. The researcher believes that the importance of this current research is as follows:

1- The importance of research lies in the importance of using technology in education to improve student involvement in classroom activities.

2- The importance of using one of the available options as one of the fruits of technology in the current era, which has many technical capabilities that help with self-learning.

3- This research helps decision takings to be inspired to set standards and foundations for greater and more comprehensive activation of the uses of this technology among students.

4- The attention to teacher's the importance of using technology in artistic activities in creating a competitive environment among students.

Mechanisms of work and Brainstorming:

Analyzing and identifying options (Areas or Uncertainty Area) In light of discussion and brainstorming between decision takings and staff, a range of different questions are asked Options that achieve both values (conceptual structures and appreciation and respect) Example: What is the cost?, How many students benefit from each option?, What are the most useful projects?, What are the chances of material and moral profit for each option?, And List the variables that are more important than others in order (from importance to importance), and Problem solving steps are used.

Definitions of Terms:

- **Influence Diagram**: A graphical and structural tool that assists the decision-taking in the event of doubt, as it is more interaction between relationships and elements of suspicion, and results in an incomplete exchange and analysis of information between team members to find out the details and information hidden in the areas of suspicion to be removed and the appropriate suspicion selected. The influence diagram is constructed from right to left (Jared, 2020).
- **Decision tree:** A quantitative, pictorial and graphical style of the elements and relationships in which the problem is formed and in light of the various risk situations. The tree diagram serves as a guide and guide for the decision taking towards showing that branch of the tree that can lead to the best results of multiple decisions in a simplified and logical way that enables the decision taking to understand and evaluate Different alternatives in the case of multi-stage decision-making, and the tree is built from left to right (William, 2019).
- **Decision:** At a given moment, in a continuous process of evaluating alternatives to reach a aim , expectations about alternatives only impose on the decision taking to choose that alternative most likely to achieve the aim (Harrison, 1981).
- **Decision Analysis:** Helps to take the important decision by choosing a decision from a group of possible alternative decisions when there is uncertainty about what will happen in the future.
- **3D Pen:** It is a new technology for 3D printing, but by using a pen, the aim is to create shapes from those paper drawings and take them into real images that people can touch and feel (Al-Ghamdi, 2019).
- **Interactive Whiteboard**: A large white screen connected to a computer that is handled by touching or writing on it with a special pen that can be used to display something on the computer screen in a clear way for all class students (Campbell, 2010).
- **Math Lab**: It is an environment in which students learn mathematics by addressing concepts, discovering facts, and applying mathematical abstractions in practical situations, and this environment is equipped with tools, manual educational materials, and modern means and technologies (Al-Doshi, 2013).
- **Achievement in Mathematics**: It is the result of what the learner acquires of knowledge, concepts and mathematical skills to develop limited educational experiences (Al Shami, 2008).

Limitation of the study:

The study is determined by the following limits:

- **Time limits**: This study was limited to its application to the second semester of the academic year 2019/2020.
- **Objective limits**: It was limited to the specific dimensions of the study objectives.
- **Conceptual limits:** The concepts presented in the research are defined as defined by the researcher in the research.

Limitations: The research focused on the importance of the influence diagram and decision tree models in making the decision to use technology in mathematics education. Therefore, the results of the search were determined by the following:

- The short period of time to conduct the study.
- Environmental conditions sweeping the region and closing schools and distance education.

Research rationale:

The reasons for choosing this topic are due to its importance, which stems from:

1- **Subjective Justifications**: Choosing this topic is the outcome of the academic journey of what the researcher has done in the decision analysis course topic.

2- **Objective justifications**: The importance of the decision-making analysis method in schools, especially quantitative methods, which dominated the new methods used at the present time.

Theoretical Literature and Previous Studies:

Theoretical Literature:

Influence Diagram: a graphical and structural tool that helps the decision-taking in the event of doubt, as it is more interaction between relationships and elements of suspicion, and results in an incomplete exchange and analysis of information between team members to find out the details and information hidden in the doubts to be removed and the appropriate suspicion selected. The impact diagrams constructed from right to left (Imran, 2019).

The importance of Influence Diagram: Giving confirmation that the team is working correctly, and it monitors for us the relationship between Uncertainty Area and risks (trade-off), and the perspective of the decision based on correct information and problem, and it is always in the first stage of the project, and this scheme serves as a means of communication and communication with giving the team and the decision-making board.

Steps to Build an Influence Diagram:

- Explain to the team why the activity worked and how it will be used.
- Begin by adopting the essence of the problem.
- Making Node Value (NPV) Revenue, Cost Price, Capital.
- Begin by developing questions into the information most helpful in resolving doubts.
- Choosing one locus of suspicion emanating from the value knot and developing it before starting another knot.
- Review the doubts from the developed list / cancel what should be removed and why.
- Defining the inevitable uncertainty knot and designing this knot using two ovals.
- Identify sources of information and write the name of each source using the node.
- Review the scheme for completeness and verify the accuracy of the problem description.
- Develop a list of tasks and necessary information.

Decision Tree: It is a grid and graphic representation showing a series of probabilistic alternatives available to the decision taking in situations of uncertainty or risk and in application of the probability theory in helping the decision taking to choose the best alternative. Probability theory is based on determining the expected value of any alternative chosen by the decision taking and after determining the expected value to obtain Accordingly, for each of the alternatives, a comparison is made between the alternatives based on the concept of the expected value by following the following steps: Determining the paths of the expected possibilities for the decision-taking facing a problem or aim and clarifying the expected results for choosing any of these paths. Modifying the probabilities of each of the expected outcomes and determining a value for each of them by multiplying the expected outcomes by the degree or percentage of their occurrence. Of course, previous experience here plays a major role for the decision taking through his judgment and modification to reach changes and numbers that are correct and close to reality. After that, the path and alternative that is expected to have the greatest expected value is determined, and this is the optimal choice and decision (Al-Azzou, 2010).

Importance of Decision Tree:

A decision tree is useful in analyzing so-called multi-stage decisions. It helps the decision making to develop a clear view of the problem structure and facilitates identification of possible scenarios that could result if a particular course of action is chosen. It can lead to creative thinking and generate choices that were not considered before. It can help the decision making to take a natural judgment on the information that needs to be grouped together. It provides us with a means to communicate and learn the details in an orderly and logical manner. And its ability to control the sequence of decisions and uncertainty (Paul, 2004).

Some Tips for Implementing a Decision Tree:

Always build the tree from left to right, paying close attention to the chronological and logical sequence of events and limiting them to meaningful events and choices. And not to overburden and exhaust the tree with very detailed options or events, or else we will find ourselves as if we are building a complete event tree and environment. Be careful to address the options or alternatives of the decision taking and the reactions, as it does not make sense to put successive options, but rather they must be in parallel, otherwise they are considered one option. And an assessment of the other party's reactions, probabilities, assessments and potential for each of the alternatives. And taking into account the future estimates, it does not make sense to take the previously paid amounts as they were paid and are no longer under the control of the decision making for individuals regarding them (Annika (2015).

Tree Building Rules:

1- There is a single node that represents the start of the tree. If there is more than one possible start node at the beginning, it creates a dummy start node to which all other starting nodes are connected.

2- Each node has access to at most one root. It is evident from this rule that there is a single path at most between every two nodes, this path represents a successive series of decisions, which in turn represents the decision-taking's strategy (John, 2004).

Steps for Building a Decision Tree:

Determine the decision / uncertainty of the impact diagram. Building a structure for the decision tree, defining the chronological order of decisions and the main Uncertainty Area. Building a complete tree, multiplying it, and connecting branches. And add the probabilities and outputs to the graph. Finally, the variables are rejected and reconsidered according to the expected value.

Decision Tree Analysis:

Finally, a decision tree is used to illustrate and find an answer to a complex problem. The tree structure allows users to easily manipulate and display many possible solutions in a simple and easy to understand manner that shows the relationship between different events or decisions. The branches farthest from the top of the tree represent the end results of the decision, each end result having to be assigned a weight or reward. The person analyzes each final result that he reaches and evaluates the benefits and losses, and the result that receives points or more is chosen as a weight for obtaining the highest benefits and least losses (Vicki, 2020).

Alternatives and Options:

- **The first decision**: the math lab, the computer lab, the iPad, the projector, the interactive whiteboard, the scientific calculator, the 3D pen, the robot.

- **Second decision**: computer, iPad, interactive whiteboard, robot.

The Usage of Technology (Scientific Computers) in Education:

The Hand computers are one of the most technological developments in this era and are used in many areas of our lives. In 2000, the National Council of Teachers of Mathematics (NCTM) proposed the use of computers as an educational tool for all teachers, and through its standards indicated that all students should have the opportunity to use it (NCTM, 2000), and it is an axiom of teaching methods (Abu al-Khair, 1988). For this reason, advocates of the use of hand calculators in mathematics education believe that this use leads to:

1- The focus becomes more on meaning, expanding children's perceptions of numbers and increasing their numerical sense (Campbell, & Stewart, 1993) in (Stiff, 2001).

2- Keeping pace with the times, and facilitating and relieving students so that they can obtain the highest marks in mathematics, which constitutes a frightening obsession (Hanna, 1999).

3- The failure of many students to complete the exam in the allotted time, as the calculator may make it easier for them (Wheatly, & Wheatly, 1988).

4- Mental arithmetic and estimation become essential components of the mathematics curriculum (Dianes and Zultan, 1985). Mathematics becomes a more enjoyable activity for students (Obeid, 2003).

5- The use of hand-held computers develops students' achievement and they have better attitudes towards mathematics (Grouws, &Cebullak, 2002).

6- Allow the teaching of new concepts that could not be learned before, such as relationships and simulations (modeling)in high school mathematics (Burrill, 1999).

7- When technology is available, why not use it as the appropriate means to solve problems (Obeid, 2003). It helps a lot in educating students with dyscalculia (Al-Khatib, 2004).

8- Computers allow students to be active learners rather than sitting passively receiving information and accepting examples from teachers where students have to give their own examples and formulate their hypotheses (reported by NCTM in Teaching with technology T3. Teachers).

9- The great role that computers play is to develop problem-solving skills and computational procedures (Seeley, 2003).

Years ago, researchers began investigating the impact of using hand-held computers on problem-solving skills, such as these studies, which all confirm their importance (Szelela, & Super, 1978), (Tarr, & et al, 2000), and (Dion, & et al. , 2001), (Suydam, 1987), (Bridgemann, 1995), and (Al-Khayyat, 2002).

In Palestine, a new trend was born among curriculum designers, as the mathematics book for the second grade of primary (Part 1) included references to training students to use the hand calculator to keep pace with the times, and based on the saying "knowledge of something and not ignorance of it".

The Usage of technology (computer lab) in education:

As for the computer, it represents the pinnacle of what modern technology has produced, as it has entered various aspects of life, starting with the home and ending with outer space, and has affected people's lives directly or indirectly (Abu Jaber and Abdel Latif, 2000). Because the computer has advantages that are not found in other educational means, it has expanded its use in the educational process, and perhaps its most important features are:

1- Interactive, where the computer responds to the event emanating from the learner and decides the next step based on the learner's choice and the degree of his response, and through this it is possible to take into account the individual differences of the learners (Sultan and Al Fantokh, 1999), and provides immediate feedback that supports and enhances the correct responses to the student (Obeid, 2004).

2- Removing fear and dread from exams and preparing for them. In fact, assessment and testing processes in their current state can generate a negative attitude in the student towards the entire learning process, but the interactive network will allow students to test themselves at any time in an atmosphere free from any risk. The testing process becomes a positive part of the learning process and will even help the student to overcome his misunderstanding and his fear of test surprises (Madkour, 2003).

3- The computer plays an impactful role in activating the role of the student and changing the role of the teacher into a mentor in the classroom. It seeks to improve the learner's performance and raise the level of his achievement in all subjects. The computer is characterized by providing educational material to the student in an exciting way, interacting with it and self-learning, which contributes to increasing his motivation. To learn and take the learning process an entertaining and enjoyable process (Al-Abadi, Mubarak, 2004).

4- The computer encourages the exchange of experiences and information among students and supports cooperative group work through joint semester studies. It also helps in developing the student's personality, and helps him learn different academic subjects in positive directions towards them (Dashti and Iqbal, 2005).

5- The advantage of the computer in repetition and repetition and presentation of information in an appropriate manner enables the learner to respond and provide positive reinforcements to him and treat errors by re-orienting or directing other information, and encourage discovery and experimentation, and it achieves the most important strategies of learning and teaching as the learning and evaluation processes are linked and this leads to mastery (Obeid, 2004).

6- Contribute to solving problems and developing algorithmic thinking skills and strategic reflection to develop steps for solving and managing the student's thinking process (Obeid, 2004).

7- Simulation of some experiences and active positive interaction with the scientific material. Computer simulation is a great educational process, as it allows students to experimentally witness any situation or phenomenon instead of just knowing the facts about it. Through it, the student can build a plan for a city in a specific social reality and study each The possibilities for the relationships and connections between factories, homes, schools and others, and thus we have entered through simulation of the "current reality" to the field of "virtual reality" and the discovery of its unknowns (Madkour, 2003).

The Usage of Technology (3D pen) in Education:

The two scientists Peter & Maxwell describe it as a pen that allows the possibility of three-dimensional drawing using a special plastic material instead of algebra. 2017). Proving the impact iveness of the 3D pen in educational practices, the researcher (Dean, 2016) used the three-dimensional pen to learn the chemical VSEPR theory, by enabling students to draw 3D images of chemical structures, which gives them an appreciation of complex geometric shapes, and the results showed its impact iveness in Students understand complex substructures more easily and quickly.

The Usage of Technology (IPad) in Education:

The iPad is a tablet device designed by Apple that plays several types of media, including newspapers, magazines, digital books, flip books, videos, music, and games (Al-Ruwaili, 2011). The educational or teaching uses of the iPad is the preparation of educational material based on the use of multimedia and software, and it also contains different types of media such as images, 3D presentations, video, audio, PowerPoint slides, Word files, a program of exciting presentations and sound impact s in an attractive way that is owned by the student and controlled as he wants.

And It has many advantages in using it in the classroom: it is an electronic bag, communication with personal educational networks, audio media, educational applications, films (Noura, 2018).

The Usage of Technology (Interactive Whiteboard) in Education:

The interactive whiteboard is a large white screen connected to a computer that is handled by touching or writing on it with a special pen, which can be used to display something on the computer screen in a clear way for all class students (Campbell, 2010). It is used in schools to serve the teacher in the teaching method, as it motivates students to participate, eliminates the barrier of shyness, consolidates information, and is useful for students of slow learning, and its advantages are: Presentation of information in a flexible and enjoyable manner. And increase the storage of information correctly. And transcend the limits of time and place. Ease of retrieval of lessons and stored information (Dajani, 2018).

The Usage of Technology (Robots) in Education:

The robot, the robot, and the robot all mean one thing, which is a mechanical device capable of carrying out activities (tasks) programmed in advance, and the robot accomplishes these activities

either at the direct instruction and control of the human being or at the instruction of computer programs, and the activities that are programmed by the robot to Their performance is usually strenuous or dangerous activities such as searching for mines and outer space and cleaning up the waste generated in nuclear reactors (Al-Khalidi and Al-Warekat, 2013).

Educational and teaching aims achieved by the school robot lab: Encouraging cooperative learning and teamwork, encouraging and developing manual work skills, encouraging project-based learning strategy or through the project, developing and enhancing students' thinking skills: (creative, critical, successful, emotional, multiplayer) as well as problem-solving skills.

How can robotics be used in the educational process?

1- Providing a group of ready-made educational robots for students in their classrooms so that they can deal with them in several ways, as mentioned earlier.

2- Providing and equipping educational robot laboratories inside schools so that students can learn how to produce robots and go through the different educational stages to produce robots capable of performing certain tasks and then try to program them for scientific purposes (Yassin, 2015).

The Usage of Technology (Projectors) in Education:

It is a tool to help deliver information in a simplified and tidy manner, and also through which educational media can be used in three ways (writing, images, video) on the use of slides in order to clarify what the teacher aims at. One of its advantages is that it helps the teacher to present his material in a sequential and attractive manner, and the ability to display data from a computer, video, television or video camera (the free encyclopedia).

The Usage of Technology (Math Lab) in Education:

It is a place provided with the necessary educational tools, devices and materials in which students learn mathematics by familiarizing themselves with concepts, discovering principles or applying mathematical abstractions in practical situations (Al-Sayed and Qasim, 2006). It can be created in several types of learning environments: a classroom math lab, a private room, or a mobile math lab. Its components include: publications, devices, teaching aids, engineering tools, sports games, laboratory activities, and models. It aims to help students understand the laws, gain sensory experiences, retain the material, increase motivation, and train some thinking skills (Khalaf Allah, 2013).

Previous Studies:

Juliette (2008) conducted research on the use of decision trees in predicting unreported crimes. The research relied on the data in the NCVS. After analysis, it became clear that there are four variables that control the process of reporting crimes. The decision tree was built based on the data after excluding unnecessary variables and the result came out that 57.4% of the crimes committed in 2005 were not reported to the police and 54.3% of the crimes were reported.

Yoshikazu (2009) study entitled Decision tree model to predict outcomes after out-of-hospital cardiac arrest in the emergency department. The researcher used the decision tree and four variables to predict hospital survival. This simple prediction model provided clinicians with a practical tool for dividing patients in the emergency department.

Kokol (2009) study aimed to build a model to predict the outcome of cardiac arrest that occurs for patients outside the hospital, using a decision tree. The results of the study stated that those who were completely cured ranged from 1.2% to 30.2%.

Kokwan (2010) study entitled Using Decision Trees to Guide the Thought Planning Process: An Improvement in the Planning Methodology. This study clarifies the usefulness of decision trees as part of the planning methodology for the state of the US military. The proposed method used decision trees to prompt planners to consider all enemy options at different stages of the plan.

WeidaTong (2011) study entitled Decision Forest: Combining Predictions of Multiple Independent Decision Tree Models, in this study the researcher proposed a new approach called Decision Forest, which combines multiple decision tree models. Each decision tree model is developed using a unique set of specifications. When models of similar predictive quality are combined using the decision-making method, the quality over individual models is coordinated and significantly improved in both the training and testing steps.

Paul (2012) study entitled Analysis and prediction of student behavior using decision trees in a Wicca environment. This study represents an implementation of an algorithm analysis tool on data collected from surveys on students of different disciplines in the college, with the aim of differentiating and predicting their choice to continue their education with post-university studies (Master's degree, Ph.D. studies.) through decision trees.

Abbas (2015) conducted a study entitled Building a Decision Tree Model to Predict Armed Conflicts in Sudan. The study adopted the empirical approach and using the data a decision tree model was built. The study recommended working on studying the reasons related to the weak influence of the factors of enemy power and enemy arming on the occurrence of the security threat.

Najari (2015) conducted a study entitled Decision-making methods in the production process, and the researcher used the decision tree and recommended the necessity of adapting to the internal and external conditions of the institution, expanding the use of computer energies, and expanding training on the use of the decision tree.

Commenting on previous studies and the location of the current study, including:

This study agrees with all previous studies in that it is looking into the field of using typical influence diagrams and decision trees in the decision-taking process. It benefited from previous studies by following the methodology of previous studies in presenting the elements of the theoretical framework and previous studies and how to discuss the results of the study, and it differs from the place of conducting the study In educational institutions, where all previous studies were conducted

in industrial institutions. This study is characterized by the fact that it focused on the method of decision analysis and the decision-making process.

Study Approach:

Decision Project Tools:

where used two models of decision analysis, namely the impact diagram and the decision tree.

Stability and validity of the Study:

To measure TheStability: Clarity, research and studies, analyze again after two weeks and work the ratio (Cronbach alpha).

To measure validity: We start the analysis process from scratch and do all the analytical and logical steps to really measure the aims.

To measure application validity: Monitor the first honesty until the risk to dependencies is removed.

Requirements for the solution required for the decision problem:

1- Identify the problem.

2- Holding sessions between the work team and the decision taker.

3- Putting all the alternatives, options and Uncertainty Area.

4- Problem segmentation and analysis.

5- Using the steps of building an impact diagram.

6- Use the steps to build a decision tree.

7- Calculation of probabilities and expected financial value.

8- Decision making.

9- Evaluation.

Identifying Alternatives and Distinguishing:

- three options required to be achieved were presented: conceptual work, practical work, and training work.
- All alternatives and options for using technology in mathematics education have been presented: iPad, projector, interactive whiteboard, scientific calculator, robot, 3D pen, computer lab, math lab.

- The value to be achieved (conceptual structures, skills, facts, appreciation and respect) has been clarified.

Solution Method for Decision Problem:

Using problem solving steps, and using an impact diagram, and a decision tree.

Evaluation Criteria:

- Academic achievement of students.
- Attitudes and values towards the subject of mathematics.

The results of the Decision Project Problem, and its discussion:

Answering the first question: What is meant by models of decision analysis, philosophy, and components?.

The school principal (decision taker) clarifies and explains the aim, and grants an amount of money to obtain material and moral value for the work team, experts and specialists. It is required to take a decision analysis of the problem / aim to be achieved through the steps of the impact plan:

1- **Explanation of the aim**: The director of the East Jerusalem Schools District (the decision taker) clarifies and explains the aim (investing an amount of 10 billion shekels) in a project with two values (both material and moral) for the work team.

- **Defining the aim**: defining the problem in cooperation between the work team (mathematics guides and inspectors) and specialists, through which the ways to invest 10 billion shekels were clarified by answering the question: What are the aspects of investment for the specified amount? (Buy computers, iPads, projectors, smart board, plotter, scientific calculator, robot, 3D pen, set up a math lab). The options for developing mathematics education were training work, pictorial work, and practical work.

- **Determines the educational aims**: that must determine the choice of the technological means used, and not vice versa that the means become specific to the goals. The possibilities provided by the technological means of communication may make modern means such as the Internet that determine the psychological educational goals. As if we were wondering how to use the Internet in school, it is logical that the means will be determined according to the needs of the educational and learning process.

- **Questions this problem**: In what circumstances would the use of technology be most beneficial? What aims can be best achieved with technology? How can the disadvantages of introducing technology in education be overcome? What kind of activities and exercises serve to achieve these aims? What guarantees are needed to carry out these activities and exercises in the best way?.

- **Analysis of options (Uncertainty Area) as follows**: training work, conceptual work, practical work, including options for using appropriate devices for the school.

1- Determining the value to be achieved by accurately designing the required net value node, in this case two values (material and moral).

2- Analyzing the options (Uncertainty Area) and identifying them in the light of discussion and brainstorming between the decision taker and the work team. A set of questions were asked to show which of the three options achieve the two values together, for example: What is the cost? How many students benefit from each option? Which projects are more useful? What are the chances of material and moral profit for each option?.

Then the following results were obtained:

- Training work (interactive whiteboard, calculator, robot): achieve material and moral value.
- Practical work (math lab, computer lab): achieve material and moral value.
- Graphic work (iPad, projector, 3D pen): Achieving material and moral value.
- In light of the above, the three options were retained: training work (interactive whiteboard), practical work (math lab), and graphic work (iPad).

In light of the above, the three options were retained: training work (interactive whiteboard), practical work (math lab), and graphic work (iPad).

3- Determining the Uncertainty Area for the chosen options in detail and breaking them down into parts, where the NCTM criteria were used NCTM Standards: Numbers and Operations, Geometry, Measurement, Problem Solving, Reasoning and Proof, Communication, Correlations and Relationships. Specifications for the use of all alternatives.

Note from the previous that these devices can be included in education, but to develop some skills in mathematics, and there are also controversial issues in the introduction of such devices in education, so it was decided to exclude these devices (scientific calculator, robot, computer, 3D pen, projector), The math lab, iPads, and the interactive whiteboard were approved.

The two Uncertainty Areas related to the proposed values were approved, and work was done to identify the Uncertainty Area related to each of them. As for the option of photographic work, (the habitat of suspicion 1) the use of the iPad emerged from it two areas of suspicion (the use of an expert, and the lack of an expert). Then a set of questions were asked: Are there A competent expert? In what areas can it be used? Does it enhance communication and communication between students? Does it improve students' skills? motivation? Can it be used inside and outside the classroom? What are the ways to improve it in the teaching-learning process? Is it possible to provide a device for each student?.

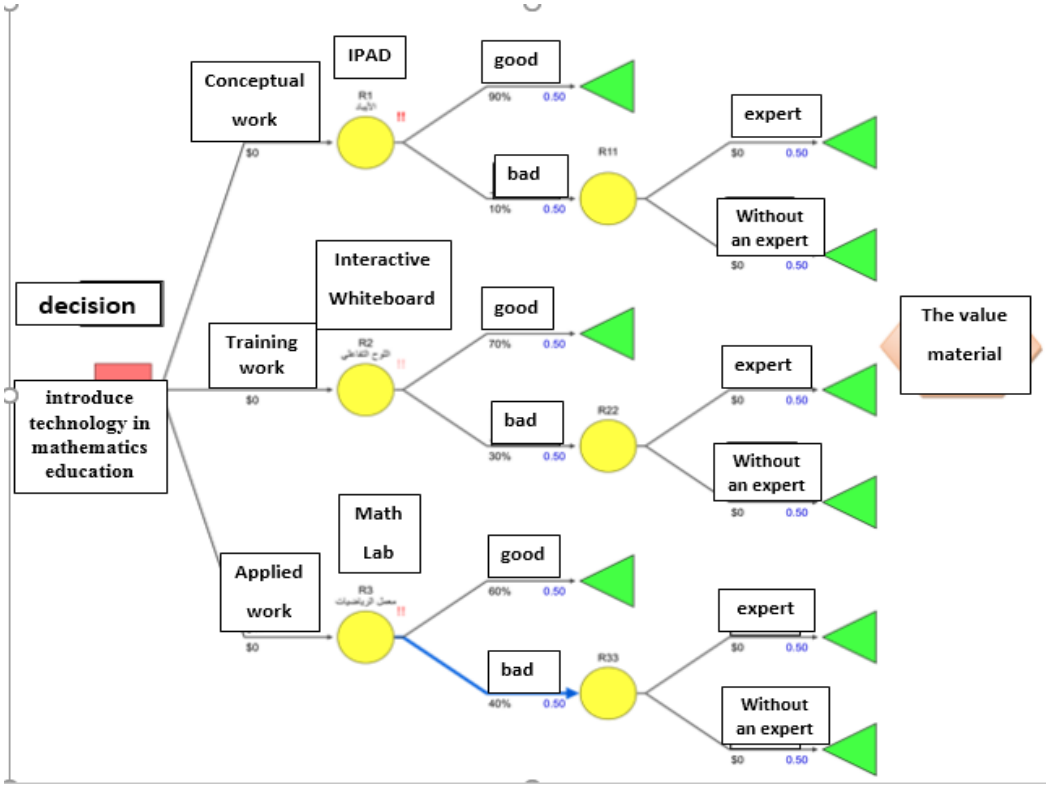
As for the practical work option, (Uncertainty Area 2) using the math lab emerged from it two areas of suspicion (the use of an expert, and the non-use of an expert), and then a set of questions were asked: What type of teacher is appropriate to be responsible for the laboratory room? Is there a room in the school? And what is its area? What tools are needed in the laboratory? Does it enhance communication and communication between students? Does it improve students' skills? motivation? What are the obstacles to using it? Is it possible to provide a smart board in the laboratory? Is it possible to provide computers in the laboratory? What goals can be best achieved with a math lab? What is the quality of the activities and exercises?.

And As for the training work option, (Uncertainty Area 3) the use of the smart (interactive) board emerged from it two areas of suspicion (the use of an expert, and the non-use of an expert), and then a set of questions were asked: What is the appropriate type of teacher to be responsible for the board? Does it enhance communication between students? Does it improve students' skills? What are the obstacles to using it? How many boards are possible? And where will it be placed?.

4- Detailing the Sub-Uncertainty Area related to each major area of uncertainty and its complete division: Each question is addressed and implemented into small parts to answer (maximum hashed). After completing the details of everything related to the chosen place of suspicion, we moved to another place of suspicion until all of them were completed, whether those related to graphic work (iPad), application (math lab) or training (interactive whiteboard).

5- Review Uncertainty Area of suspicion, identify the relevant important and delete the unimportant.

The result we got from the impact diagram



Decision Tree:

1- Determining the desired decision, and the locus of suspicion chosen from the impact diagram:

Based on the impact diagram, the decision was determined to invest an amount of (10 thousand dollars), and then through experts and specialists, three areas of suspicion were identified: The first suspicion is the photographic work, and from it the option to use the iPad and two areas of suspicion (using an expert, or not using an expert) were launched from it. The second Uncertainty Area is the practical work, from which the option of using the mathematics lab started, and two areas of suspicion (the use of an expert or not using an expert) began, and the third area of suspicion, the training work, from which the option to use the interactive board started, and two areas of suspicion (the use of an expert or not to use it began).

2- Building a structure for the decision tree: A structure for the decision tree is built, in which the chronological order of decisions is determined according to their sequence, the Uncertainty Area in them, and the branches emanating from them, and according to the decision (the use of technology in teaching mathematics) it is placed in a box to the left of the paper, followed by three Uncertainty Area Each of them is related (pictorial work (iPad), applied (math lab), and training (interactive whiteboard), (they are placed inside circles / uncertainty nodes) and each area is followed by two sub-areas of uncertainty related to each of them (using an expert or not using an expert), also (They are placed in circles).\

3- The third step: Building the complete tree with all the branches emanating from it, (options and alternatives).

Figure No. (6): triangle , It is the end of the tree branch. and It Uncertainty Area, It decision.

4- Reviewing the built tree: The process of reviewing the built tree to ensure that all the required data and information, and the main areas of suspicion, and those subordinate to them are present.

Decision taking (back-to-back): We note that the tree-reversal method allows analysis of a complex decision problem as a series of small decision problems and provides sensitivity and probability analysis.

5- Start by solving the tree from right to left (Rolling Back), to calculate the expected values.

The solution is according to a mathematical equation through which the total sum of the probability of each output, value or path multiplied by its percentage is calculated, with the need to take into account the mathematical signs (plus and minus). We start with the process of calculating the value of each possibility from left to right in order to make the optimal decision.

Uncertainty Area(R11): (Conceptual work: iPad) The decision taker has two options, either to use the expert and bear the costs of $ 15,000 annually, or not to use it and bear the costs of $ 5,000 annually, and therefore he will decide the rational option not to use it as it is less expensive.

Uncertainty Area(R22): (Training Work: interactive whiteboard) The decision taker has two options, either to use the expert and incur the costs of $8000 annually or not to use it and bear the costs of $12,000 annually, and therefore he will decide the rational option to use it as it is less expensive.

Uncertainty Area(R33): (Applied Work: Math Lab) The decision taker has two options, either to use the expert and bear the costs of $15,000 annually, or not to use it and bear the costs of $5,000 annually, and therefore the rational choice will be decided not to use it.

Uncertainty Area(R1): If you decide to buy iPads, there is a 90% chance that they will be in excellent condition and will incur costs of $10,000 annually, and a 10% chance that they will be bad and annual costs equal to $5,000. We apply in this uncertainty the expected value method:

EMV(R1) = -10000. 90% -5000 .10% = -9500

In the sense that the expected value of all branches of this node is equivalent to -9500 dollars annually.

Uncertainty Area(R2): If you decide to buy interactive whiteboard, There is a 70% probability that it will be excellent and will incur costs of $14,000 annually, and a 30% probability that it will be bad and annual costs of $7,000, we apply this node the expected value method:

EMV (R2) = -10000.70% - 7000. 30% = -11900

In the sense that the expected value of all branches of this node is equivalent to -11900 dollars annually.

Uncertainty Area(R3): If you decide to buy math lab, There is a 60% chance that the services will be excellent, and you will incur costs of $5,000 annually, and there is a 40% chance that they will be poor and have annual costs of $8,000. In this node we apply the expected value method:

EMV (R3) = -5000. 60% - 8000. 40% = -6200

In the sense that the expected value of all branches of this node is equivalent to -6200 dollars annually.

3-Review the tree that is designed:

The process of reviewing the tree that was built to ensure that all the required data and information, and the main areas of suspicion, and those subordinate to it are present.

Decision: The decision taker has three options either to buy an iPad and bear the expected costs of $-9500 annually, or to buy an interactive whiteboard with an expected value of -11,900 dollars annually, or to use the math lab with an expected value of $-6200 annually, and thus he will decide the least costly rational option i.e. **Usage the math lab**. The optimal strategy for the decision taker,

as shown in the decision tree, is to **use the math lab** and choose to use it if the services are bad, and if the services are excellent, there are no other options.

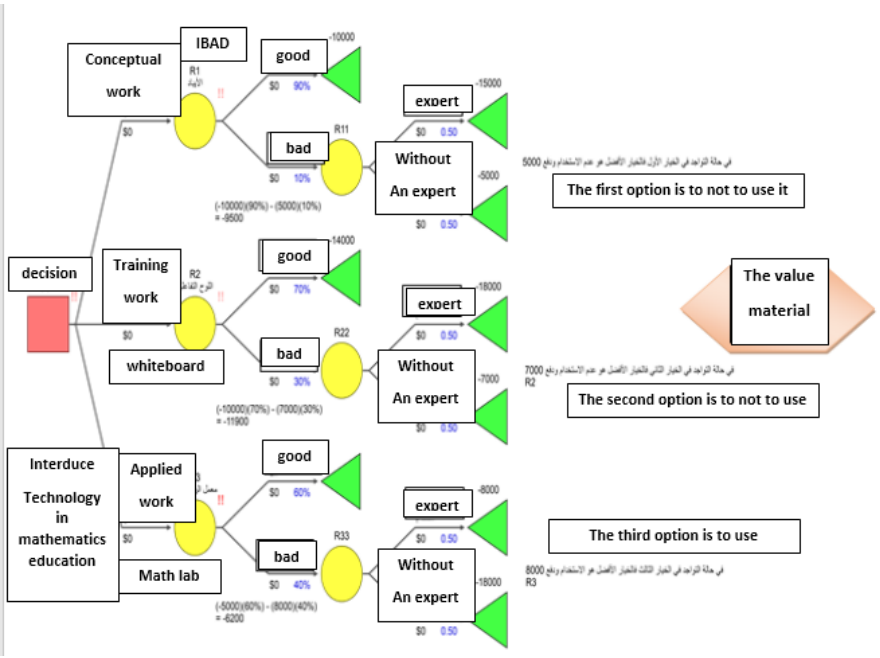


Figure No.(3): decision tree

Figure No. (3): triangle , It is the end of the tree branch. and its Uncertainty Area, Its decision.

Answering the second question: What is the role of decision models in analyzing the decision problem to reach the expected value?.

Advantages of Using Influence Diagrams in Decision Problem Analysis:

- Influence Diagrams: are a tool for depicting the decision problem graphically, through which we can see the relationships related to decision-taking, as they serve as a means of communication and communication with the team and the decision-taking board. Diagrams are a very powerful tool for showing all sides of the problem on one page, as they give us clarity for the decision, and thus be a tool that reduces ambiguity (relationships between uncertainty, values), and the points of decisions are clear. Diagrams are a great help for people who are unable to clearly understand Aims. The impact diagram is usually at an initial stage of the project and before the work is evaluated in order to ensure that the team is working on the right problem. As an assessment tool, the decision model is the quantitative driver of insight construction, and the assessment usually operates at a stage of increased complexity.

- impact diagram: A graphical tool used to control the problem and the flow of communication." They are not flow diagrams and there are no feedback loops as there is no path that allows it. It begins with the criteria of values and the question: What do you want to know to determine the value? Then we continue to segment the problem until you find an expert who provides us with the appropriate assessment (NPV). The goal here is to communicate and evaluate the interaction of decisions, uncertainty, and values (relationships). Impact diagrams are like art and science (Vick M, 2020).

Advantages of using decision tree in decision problem analysis:

- The characteristics of the decision tree forced the decision taker to follow the scientific method in analyzing decisions.
- It forces the person to clarify his assumptions and put them on paper, taking it easier for him and others to choose the accuracy and follow-up of these assumptions and alternatives.
- The decision-taker can take the risk of choosing using the method of preference theory, and use the decision tree to reach the preferred choice according to this method.
- see how sensitive the final decision is to these assumptions and suggestions.
- The ability to take advantage of additional new information (feedback).

Answering the third question: What is the role of decision models in analyzing the decision problem to reach the expected value?.

When we first encounter some decision problems that seem very complex and contain ambiguity and uncertainty in these circumstances influence diagrams and decision trees can be very useful in helping people understand the structure of the problems they face.

Influence diagrams offer an alternative way to organize a complex decision problem, and some analysts find that people deal with it more easily. In fact, Howard (1988) called it "the greatest advance in communication inference and the detailed representation of human knowledge...the best tool I know for crossing a bridge...a vague state in one's mind which is the basis of a clear and pure decision".

Influence diagrams are a way of extracting options and alternatives that are formed to summarize the dependency that is perceived to exist between events and actions within a decision. These dependencies are mediated by the flow of time. In this research, there was a close relationship between the impact diagrams and the decision tree, in fact, given the conditions of the ministry's requests and conditions, the analysis was done and the two models were used (converting the impact diagram to a decision tree). the decision. After building the impact diagram the diagram was discussed with the management as there is a lot of information for evaluation hidden behind the node.

So When constructing the decision tree, a valid sequence of decisions and uncertainties that must be resolved before moving on to the next decision is reinforced. Then the decisions were arranged.

The Step-by-step procedures for converting an impact diagram into a decision tree:

1- Select a node without the arrows we refer to (because there can be no nodes, at least one node is formed).

2- If there is a choice between a decision node and an event node, we choose the decision node.

3- place the node at the beginning of the tree and file the node from the impact diagram.

4- At the moment, choosing a new chart and another node with no arrows to point out. If there is a choice of a decision node it must be selected.

5- place the next node in the tree and remove it from the impact diagram.

6- repeat the above procedure until all nodes have been removed from within the impact diagram.

Abstract of the results of the Project diagram:

The decision-taking process has gained importance, becoming the main activity of managers, and the efficient manager is the one who takes the good decision, relying on the principle of rationality and achieving effectiveness.

In light of the rapid developments in various fields, there has emerged an urgent need for the existence of practical and logical tools and methods that help in taking decisions and providing assistance to solve the problems facing educational institutions. decision analysis.

In this research, the two models and quantitative methods contributed to reducing the cases of uncertainty and also contributed to the development of adaptation and rapid adaptation to the work environment in the educational institution, and by using the steps to solve the problem, the results of the research came as follows:

The optimal strategy for the decision taker, as shown in the decision tree, is to use the math lab, and to introduce the computer into the lab.

Recommendations:

Based on the findings of the research, some recommendations can be summarized in the following:

1. Emphasizing the importance of using quantitative methods as aids in taking decisions in educational institutions.
2. Searching for quantitative methods and new methods of decision-taking that would contribute to activating and rationalizing the decision.
3. Expand training the student to use the analysis process, problem segmentation, and quantitative methods, and move from the impact diagram to the decision tree, to use them in the tools he needs in his work, and this tool greatly helps in taking the closest decision to the right in all community activities.

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