

Project ID/Title: RIGS15-157-0157: Inculcating Values in Mathematics Classroom via Problem Solving: Helping Teachers Design Meaningful Lessons

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Abstract: Every culture in the world emphasize values which their community members broadly share. These values are inculcated either implicitly or explicitly through family, society and educational institution. Since children spent much of their time at school, it should be a place that supports families' and communities' efforts to establish strong values in students. Inculcation of values could be done across the curriculum. However, research on values in mathematics education has only been popular in the past few decades. Since mathematics is imbedded in many different aspects of everyday life, it is an appropriate subject to incorporate values in, which will make students see the relevance of what they are learning better. In this study, teachers were helped in their design of lessons so that meaningful lessons could be produced, in order to ensure effective teaching and learning processes are implemented. This pre-experimental design study involved a combined Year 4 class of 35 students from one international school as research participants. Two teachers participated directly in the study, while some others acted as observers. Both qualitative and quantitative data in the form of observation field notes, interview data (from both students and teachers), tests, questionnaires and observation checklists results were collected. The data was used to answer the research questions on changes in students' performance and attitude, both in the mathematics topics taught and also on their moral reasoning. The results shows increased but non-significant scores in mathematics. There are also improvements in moral reasoning based on students' written answers of some moral questions, which is also supported by the interview data. The observation data displays a gradual improvement of students' in-class behavior in terms of their attitudes towards each other and towards the tasks and activities given. This study implies the possibility for students to learn about morality and values in a mathematics class through careful planning of tasks and activities. It highlights the belief that values can be learned across the curriculum, which is one of the important factors in building a nation of caring and civil society.

Key words: Mathematics Problem Solving, Meaningful Mathematics, Mathematics teaching and learning, Inculcation of values, Values framework, Akhlaq, morality and values.

INTRODUCTION:

Ethics and values are the basis of many civilizations and form fundamental parts of morality. Values are principles or standards of behaviour or “one’s judgement of what is important in life” (Oxford, 2016) that determine one’s conduct. Values are also shaped by particular long lasting beliefs shared by the members of a culture, religion or community (Stacey, 2016). Besides universal values, we may say that believing Muslims subscribe to Islamic values, while people of other communities subscribe to their own values. Islamic values are generally strictly observed by practicing Muslims because they are prescribed by God Almighty in the Quran and were practiced by the Prophet, Muhammad (*pbuh*). These values are not the result of spiritual development, but that which have been enshrined by Islamic law since fifteen centuries ago. The Prophet is a shining example of perfect moral behaviour, and he saw it as his priority to restore the *ummah*’s behaviour as narrated in a *hadith* “I was only sent to perfect good *akhlaq*” (Musnad Ahmad). The Qur’an praised the Prophet as someone with the most beautiful conduct and that his moral character is the Qur’an. The importance of moral character was further highlighted when the Prophet said that “the best among you are those who have the best manners and characters” (Sahih Bukhari, 4: 759).

However, in the daily newspapers or any news portal today, robberies, murder and violence against women, children and the elderly seem to dominate the headlines. The same can also be said about news related to corruption, frauds and scams. We cannot help but wonder what is happening to the world today, and sadly, to Muslim countries such as ours. People seem to have lost direction as a result of poor moral values and care less if they have broken the moral code of conduct. As educators, we can play a very big role to improve this situation especially during the schooling age of children. Hence it is important for us to examine our education system because education plays a significant role in inculcating values and norms into children. During the school-going age, children are at the conventional level of moral development (Kendra, 2016), where their moral reasoning is to conform to the social order. It is therefore, crucial that all lessons are injected with moral underpinnings.

According to Al-Attas (1980), the aim of education is to produce a good man. A good man according to him is a man who possesses *adab*, someone who is “sincerely conscious of his responsibilities towards the true God; who understands and fulfills his obligations to

himself and others in his society with justice, and who constantly strives to improve every aspect of himself towards perfection as a man of *adab [insan adabi]*" (Al-Attas, 1980). This concurs with what was earlier said by Al-Ghazali, that the aim of education is for the formation of good character, cultivation of virtue and also the eradication of ignorance (Totah, 1026). He stated that when students take their lessons seriously and put them into practice, then the teaching of moral values becomes effective (Halstead, 2007). He also stressed on the importance of teachers as models of good character and moral values because students usually emulate their teachers in a subconscious manner. Similarly, Al-Farabi is believed to have said that the aim of education is to lead individuals to perfection, and the goal of humanity's existence in this world is to attain happiness, which is the highest perfection. He described a perfect human being as one who has obtained theoretical virtue, having completed his intellectual knowledge and acquired practical moral virtues, hence becoming perfect in his moral behaviour. Ibn Sina sees the aims of education as the overall growth of the individual: physical, mental and moral, followed by preparation of this individual to live in a society through a chosen trade according to his aptitude. Education in Islam, according to Ibn Khaldun, is not just an integral part of civilization, but more importantly, for someone to know Allah's law that was prescribed for the purpose of attaining *ma'rifat* by practicing the rituals and is always oriented towards inculcating Islamic values (Ibn Khaldun, 2008).

It can be seen from above that all of the scholars mentioned character and moral values as the most important part of education besides seeing to the overall growth of an individual which include the physical, mental and spiritual element. The significance of these elements are reflected in the Malaysian National Philosophy of Education (NPE), which is stated as follows:

Education in Malaysia is a continuous effort towards enhancing potentials of individuals in a holistic and integrated manner in order to create individuals who are well-equipped intellectually, spiritually and emotionally. This effort aims to produce knowledgeable, ethical and responsible Malaysian citizens who can contribute towards the harmony and prosperity of the community and nation (MOE, 2012, pp E4).

NPE is supposed to act as a guide for all educational activities in Malaysia, which sets the values and principles of the Malaysian education system from the primary to the tertiary levels. NPE's aims and objectives are to produce individuals who are knowledgeable and full of integrity, who will contribute as responsible citizens. A balanced emphasis should be on all of the four elements – physical, intellect, emotional and spiritual. However, an over emphasis of intellect in today's educational institutions has made other elements, especially

spiritual, neglected or overlooked (see Figure 1). The balance seems to be more skewed towards intellect due to the disproportionate focus on the academic side of education. Therefore, it is not surprising that the state of the society is what it is now. Although there are other factors that lead to this situation, the increase in white collar crime and minimal concern about integrity, honesty and ethical behaviour is a cause for concern. Sadly, this is happening a lot in Malaysia now, where the increasing trend in white collar crime is said to be alarming. Therefore, there is an urgent need for schools to stress on the inculcation of values to children.

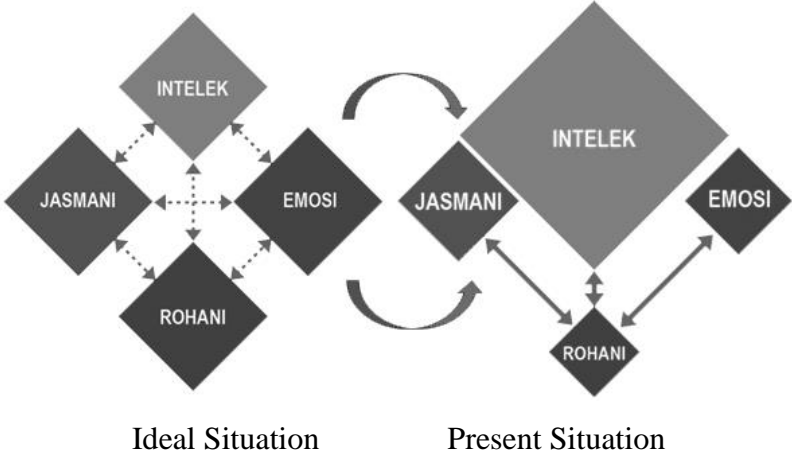


Figure 1: The emphasis on intellect instead of balance in today’s education

While the development of values in a child starts from home, there exists ample opportunities for teachers to teach the principles of values education through existing subjects and topics or across the curriculum, including mathematics. Although mathematics has often been thought of as a value-free subject, it can be argued that since mathematics deals with everyday life, it is an appropriate subject to incorporate values to be inculcated in the students, especially through problem solving. One of the best Islamic real-life problems that can be turned into a class task that teaches value is related to the law of inheritance (Fara’id), where students can be apply Algebra. Although the work of Al-Khwarizmi, Al-Karaji and Al-Samaw’al in Algebra and that of Thabit bin Gurra, Ibrahim bin Sinan, Al-Farabi and Abu Sahl in Geometry will be too advanced for the children that this framework is targeted, their stories would inspire the Muslim children to revisit the glorious achievements of Islamic mathematicians.

School is where children go for organized education. It is also here that extensive enculturation occurs, which encompasses other activities which are not only aimed at increasing knowledge and ability, but also at acquiring norms and values. Teaching also includes the usage of educational aids or manipulation which serve in a meaningful way to improve results and also to heighten the readiness for taking on responsibilities. Accordingly,

schools, apart from its main function as a place for teaching, also has the task of providing moral education. Often, teaching values have been associated mainly with the religious or moral subjects. However, Bishop stated that values are an inherent part of all educational subjects at all levels, from the “systemic level, institutional macro-level, through the meso-level of curriculum development and management, to the micro level of classroom interactions.” Nonetheless, Bishop then remarked that the notion of studying values in Mathematics education is a relatively recent phenomenon. *Values* are at the heart of *teaching* in any subject, but are rarely explicitly addressed in the *mathematics teaching* literature. Fortunately over the years, there has been an increase in the number of research in mathematics education incorporating values.

This rationale for emphasizing Islamic values in schools across the curriculum and in mathematics education has been discussed above. The remainder of the paper will explain Islamic values particularly in the mathematics classroom; reminisce the Islamic golden era where mathematics is part of the Islamic tradition; consider the suitability of problem solving process for inculcation of Islamic values in mathematics classroom and present the conceptual framework. This is followed by the detail account of the study – its objectives and methodology; the results and finally discussion and conclusion.

BACKGROUND:

Islamic Values

The mention of Islamic values would naturally lead people to think of those values practiced by Muslims. While this might be true in some cases, it cannot be assumed that Muslim values and Islamic values are the same. Since Islam is practiced by a very diverse group of people, Muslim values are usually culture bound and can differ from country to country (*urf*), while Islamic values are already ordained in the Quran and are from the *sunnah*, as was already defined before. As an example, honour killing is not part of true Islamic values although it is practiced in some Muslim communities because Islam upholds the sanctity of human life. Islamic values can be categorized into three: 1) *akhlaq*, which refers to the duties and responsibilities set out in the *shari'ah* and Islamic teachings 2) *adab*, which refers to manners associated with good breeding, and 3) virtue – the qualities and character possessed by a good Muslim, following the example of the prophet Muhammad. Yusuf Al-Qaradhawi divided *akhlaq* or moral values further into six categories of relationship: self, family, society, the animal world, the physical world and the creator. On the other hand, *adab* means “good manners” and finally, virtue which include sincerity, responsibility, humility, kindness,

helpfulness, etc. The list of good values and manners is profound and Al-Ghazali stressed the meaning of education in sowing good character in children so that they could evaluate between right and wrong. He also recommended that the teaching of Islamic values starts as early as possible. The attempt for the development of values framework in this study is to have something concrete that teachers can adhere to in trying to shape students' akhlaq at the elementary level. Many people have argued that the teaching of values would be more effective and meaningful if taught across the curriculum, which the writers agree. This paper will however focus on the curriculum framework for the teaching of Islamic values only in mathematics education for the purpose of research on inculcating Islamic values through problem solving in the subject of mathematics.

Values in Mathematics Classroom

There is a widespread misunderstanding that mathematics is a value-free subject. However, many educators should be aware that values are imbedded in the teaching and learning in mathematics classrooms, whether implicitly or explicitly. Seah stated that there are three different aspects associated with values and mathematics education – values through mathematics education, i.e. to incorporate values into existing mathematics curricula and approaches to teaching mathematics; values of mathematics education, i.e. the socio-political and cultural values that are implanted in mathematics; and values for mathematics education i.e. the ways where teachers employ what they and the students value to enhance mathematical understanding and competence. This paper, however, will focus on the teaching of values through mathematics education, aptly known as teaching mathematics through problem solving.

Mathematics encompasses skills and functions which are parts of everyday life. Hence honesty can be inculcated in classroom activities of buying and selling; understanding money can lead a person to be frugal with money; reading of maps and direction can be associated with finding the direction of the kiblah and stressing on the importance of prayers; and estimation can be taught through estimating how much to buy when marketing so that everything can be used. This will eradicate wastefulness, all of which may be incorporated through the teaching of problem solving or the problem-solving approach.

Tradition of Islamic Mathematics

Mathematics covers almost every aspect of human life, although some people may not realize it. Mathematics, being the language of all sciences, has been used to describe the patterns and structures found in nature and plays a central role in the modern world. Some pursue

mathematics for its beauty and intellectual challenge while others such as scientists or engineers applies it as part of their everyday jobs. Solving or applying it to everyday problems has led the people to discover new terrains that enrich the field itself. The development of Al-Jabr and Geometry during the Islamic Civilisation for instance, can be attributed to the needs of the people in performing their duties in Islam. Al-Khwarizmi mentioned that his primary reason for composing his book, *Kitab al-jabr wa-l-muqabala* was "to help people solve the problems they encountered in their daily lives such as their inheritance (fara'id), their wills and testaments, their share allocations, judgments, commerce and all that they deal with among themselves such as surveying lands, digging of canals, engineering, and such things"²⁶, although it also contain abstract theoretical considerations.

The level in the study of trigonometry flourishes due to the Islamic ritual requirement in the religion. The need to locate the position of the Ka'aba for daily prayers in Islam has steered Muslim mathematicians to use spherical geometry which led to the development of sine and cosine laws, and the knowledge of latitudes and longitudes. This and the religious requirement for pilgrimage to Mecca has led to the invention of astrolabe for the purpose of determining the direction of Mecca and also the distance to Mecca from other cities. These are just a few examples of the inventions by Muslim scientists that developed out of the need to solve everyday problems. Thus the importance of problem solving should be stressed in any classroom that may consequently led to new inventions.

Mathematics Problem Solving

Carson provided the following definition of problem solving in mathematics: Problem solving is the means by which an individual uses previously acquired knowledge, skills, and understanding to satisfy the demands of an unfamiliar situation. The student must synthesize what he or she has learned and apply it to a new and different situation. Problem solving is considered a teaching method that develops the students' thinking skills which enables them to apply conceptual knowledge to real life situations and stimulates students' learning. Haji stressed that students should be given the chance to participate freely in problem solving. The teachers' role is to guide students through the use of metacognitive skills and develop critical thinking and problem solving skills to solve a given problem, hence enabling them to apply these skills to solve real life problems. In addition, the problem solving approach develops moral skills in students and teaches them to be responsible for their own education in searching for information, analyzing the problem and presenting the best solution.

Problem solving is one of the methods employed by our Prophet Muhammad (*pbuh*) in teaching about the religion of Islam. It was narrated that the prophet presented a good example

in problem solving when he was called by the Arab tribes at the time of building the *Kaabah* in order to solve the problem of which tribe should place the Black Stone on the wall of the *Kaabah*. The Prophet (*pbuh*) suggested that each tribe choose one representative to carry the Black Stone on a piece of cloth and then he would place it himself in the proper place. His wise solution was accepted by all tribes.

Problem solving is an effective approach for educating students about life by promoting interest and context, developing thinking and common sense and giving students the power to strategize. In particular, it is an approach which encourages flexibility, the ability to respond to unexpected situations or situations that do not have an immediate solution and helps to develop perseverance in the face of failure. A problem-solving approach can provide a medium for students to construct their own ideas about what they are learning and to take responsibility for their own learning. While these are all important problem solving skills, they are also important life skills and help to expose pupils to values education that is essential to their holistic development. Additionally, problem solving is considered as one of the most important skills in the 21st century that a student should possess where the ability to solve non-routine problems in everyday life and in the workplace is desired.

Problem solving in mathematics education is defined as “engaging in a task for which the solution method is not known in advance”. In the process of problem solving, students must utilize their knowledge in trying to find a solution to a problem, a process which would lead to new mathematical understandings. Other traits that students could acquire by learning the method of problem solving in mathematics are, “ways of thinking, habits of persistence and curiosity, and confidence in unfamiliar situations that will serve them well outside the mathematics classroom”. Therefore, problem solving should be considered an integral part of mathematics learning, and it should not be viewed as exercises that students perform at the end of every topic from the school textbook.

Other benefits of problem solving include 1) It makes learning mathematics interesting and enjoyable; 2) Mathematics is learned in a new way with greater understanding; 3) It produces positive attitudes towards mathematics; 4) It teaches thinking, flexibility and creativity; 5) It encourages logical reasoning; 6) It encourages mathematical communication; 7) It teaches general problem solving skills; and 8) It encourages cooperative skills. Presenting a problem and developing the skills needed to solve that problem is more motivational than teaching the skills without context. It allows the students to acknowledge that there is a reason for learning mathematics, and hence they become more deeply involved in learning it. Teaching through problem solving offers students all of the benefits mentioned and at the

same time helps students to decide any rule, if necessary, a situation requires or if they need to develop their own rules in situations where an existing rule cannot be directly applied.

Taplin listed three types of problems to which students should experience in the classrooms:

- i. “Word problems, where the concept is embedded in a real-world situation and the student is required to recognize and apply the appropriate algorithm/rule (preparing pupils for the challenges of life)”
- ii. “Non-routine problems which require a higher degree of interpretation and organization of the information in the problem, rather than just the recognition and application of an algorithm (encouraging the development of general knowledge and common sense)”
- iii. “Real” problems, concerned with investigating a problem which is real to the students, does not necessarily have a fixed solution and uses mathematics as a tool to find a solution (engaging pupils in service to society)”.

The first type of problem (in (i)) requires direct application of rules and concepts, where students just need to select appropriate existing knowledge to solve them. Fermi problems (where information given is not enough to solve a particular problem and requires children to locate the necessary information) can also fall under this category. In non-routine problems, children are encouraged to use their logical thinking, which can reinforce their understanding of the concept taught. They need to apply problem solving strategies that they may have applied before but in other situations. Finally, in the ‘real’ problems, students need to plan, carry out and check or extend their solution using certain models. As an example, **Polya** suggested a 4-step model that includes 1) understanding the situation 2) planning the solution 3) carrying out the plan and finally 4) checking and extending the solution. Of course there are other models of problem solving such as **Bohan, Irby** and Vogel, who suggested 7-steps to come up with a solution. The kind of task that is suitable for teaching through problem solving mostly comes under category (iii), that will hopefully turn students into producers of knowledge rather than consumers. Suitable problems are those that requires students to investigate and enquire by asking themselves certain questions to understand the situation. They are encouraged to communicate with their friends to collaboratively solve the problem and employ their mathematical thinking and reasoning. Through cooperative learning that is being suggested in the problem solving model, students will also acquire the value of collaboration.

We have now established the benefits of teaching through problem solving and how this

process of teaching would be able to inculcate the Islamic values that we want the children to acquire. There are of course disadvantages of teaching through problem solving and among them are teachers' discomfort and students' insecurity because both parties are used to the traditional way. Teachers' obsession on completing the syllabus made them to teach the topics on the surface where they resort to focus on procedures rather than understanding. The length of time taken is another reason since teaching through problem solving requires a lot of preparation. The next question would be whether our teachers would be ready to implement it. The normal way of teaching teachers about curricular changes is to have them undergo a training by attending a workshop or continuous professional development (CPD). One of the CPD that meets most of the criteria for effective professional development is lesson study. This study initially plan to incorporate lesson study to train the teachers design meaningful lessons. Due to time constraint and difficulties in getting the cooperation of all parties involved, the idea have to be abandoned.

The Conceptual Framework

Now that every step of the process in inculcating Islamic values has been explained, a diagram is designed to consolidate all the information. Figure 3 shows the visual framework that is developed according to the components and steps described above.

It was stated earlier that according to several Islamic scholars, the main aim of education in Islam is to produce a man of good moral values or character. This is achievable if there is synergy in efforts between home and school in each and every aspect of a child's life starting from a very early age. The innermost circle in Figure 3 is the main target of the research, i.e. inculcating Islamic values, which is made of three factors, that is *akhlaq*, *adab* and Islamic virtue from following the *sunnah* of the prophet Muhammad (*pbuh*).

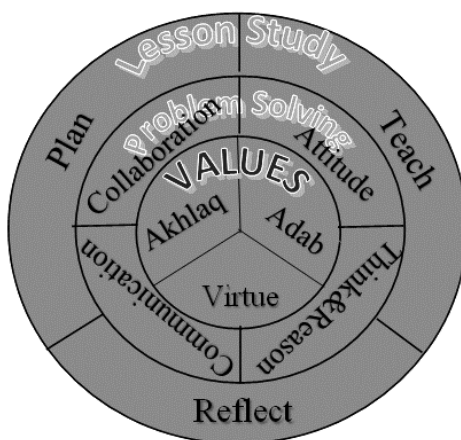


Figure 3. The framework showing problem solving in mathematics as an approach for inculcation of Islamic values. However, lesson study to be the vehicle to train the was not incorporated.

It has been recommended that values education be taught across the curriculum and since mathematics is one of the core subjects at every school level, it would be one of the best subjects to be integrated with values education. It is undeniable that human beings from every culture and at any time have used mathematics, i.e. mathematics is an essential discipline because of its practical role to the individual and society. Consequently, the second ring around the target values circle represents problem solving as a process that will be employed for inculcating Islamic values. It can provide students with a context for learning mathematical knowledge, enhance transfer of skills to unfamiliar situations and is an aesthetic form in itself. A problem-solving approach can provide an avenue for students to construct their own ideas about mathematics and to take responsibility for their own learning. In order to ensure that values are inculcated through problem solving, the right task is crucial, because it can lead students' enhancement in both mathematics and moral values.

Four components have been identified as important for the success of the problem solving process that will in turn instill the desired values. The first component identified is applying logical reasoning and mathematical thinking, which is what students must do in solving problems in mathematics. During the process, students connect ideas and gain a deeper conceptual understanding using these elements of problem solving, questioning and debating about certain Islamic values that is embedded in the task. This will be different from the traditional way values are normally taught. The second component is communication, an important element for the reason of explaining strategies, processes or ideas so that the solution statement is evident from the details provided. Communication requires the use of appropriate mathematical language/ notation. Since language is a tool of thinking, communication is vital for reasoning and thinking and in this case students need to think to be able to ask questions, and not just accept anything at face value. The third component, collaboration, will encourage students to work together towards finding a solution. In addition, collaboration or cooperation itself is an important Islamic value. The final component, attitude, refers to students' mindset during the problem solving process, whether they strive hard or are laidback when solving a problem. These components form very important aspects of the process of teaching mathematics through problem solving.

Thinking and reasoning are powerful processes that lead students to do the right thing. Students should be exposed to moral thinking and reasoning and not be expected to blindly follow rules and orders to become a better person. As part of the process of problem solving in mathematics, students will be exposed to these and thus use them in making moral

judgements. The following verse from the Quran clearly indicate Allah’s disapproval at those who do not reason,



which means “Indeed, the worst of living creatures in the sight of Allah are the deaf and dumb who do not use reason”.

Communication is another important component of problem solving. Teachers know what students are thinking through communication, whether in writing, through gestures or words. Teachers could gauge students’ attitudes, understand students’ thinking or misconception, help students make sense of their learning and even recognize and appreciate another perspective, all through communication. Having a developed communication skill is an asset in itself because it is considered as part of the 21st century skills most sought out by employers. In addition, communication during problem solving would lead students to better communicate with other people in their life. Of course the best person to emulate in terms of communication is the prophet, who has the best communication etiquette. Islam encourages communication with our own selves, with Allah s.w.t., with the Quran, with fellow human beings, in fact with all of God’s creation.

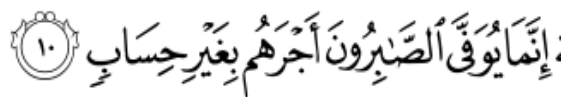
In order to encourage communication and as mentioned above, students should be trained to work in teams where collaboration is essential. Meaningful cooperation and collaboration is a basis of **Islamic brotherhood and harmony among Muslims with an aim to encourage what is good and discourage what is evil. In the case of problem solving, collaboration among peers leads to instructional scaffolding. Prophet Muhammad (pbuh) was reported to have mentioned the following in a hadith:**

“Truly the faithful are to one another like components of a building – each part supports the other”

Problem solving that divides students into groups of cooperative learners will encourage communication and hence brotherhood, teamwork, interpersonal skill, and even leadership skill.

People used to think of learning mathematics as solving routine problems in a solitary manner. Studies conducted in Malaysia show that cooperative learning in mathematics enhances students’ achievement and problem solving skills. It was also found that cooperative learning inculcates values such as independence, love, cleanliness, hard-work and rational thinking and also enhances scientific skills and promotes enquiry learning. Attitude is identified as another important component. Students’ attitude and beliefs about mathematics

is largely dependent upon the way mathematics is presented to them. A traditional way of teaching and learning mathematics will make students believe that mathematics is a fixed body of knowledge where formulae is memorized and a lot of practice is needed to master it. The Singapore mathematics curriculum framework identifies attitude as one of the five components of problem solving, where the emphasis in the framework on affective issues includes appreciation, interest, confidence, and perseverance, in learning mathematics is highlighted. Helpful beliefs and attitudes is identified by **Kaye Stacey** as one of the skills and abilities in problem solving. Alan Schoenfeld, on the other hand, identifies beliefs as a mathematical "world view" that determines how someone approaches a problem. Patience and perseverance is encouraged in problem solving in order to arrive at the solution and is also a character encouraged as mentioned in part of the **Quranic verse (39:10)**,



“... Only those who are patient shall receive their reward in full, without reckoning”.

The outermost ring represents how the teachers will be practically learning the skill to teach mathematics through problem solving via lesson study. Since teaching mathematics via problem solving can be something new to the teachers, the lesson study was initially included to help teachers learn and understand the process of teaching it collaboratively with other teachers involved, together with the help of a knowledgeable other. Many countries around the world now are practicing lesson study as the Continuous Professional Development for their teachers, although the Japanese teachers are believed to have started it 130 years ago.

“In Japan, math educators have been thinking about how to develop problem solving for several decades. They studied George Polya's “How to Solve It”, NCTM's “Agenda for Action”, and other documents, and together, using a process called “lesson study”, they began exploring what it would mean to make problem solving “the focus of school mathematics.” Today, most elementary mathematics lessons in Japan are organized around the solving of one or a very few problems, using an approach known as “teaching through problem solving.”

Research Objectives:

For many reasons, the state of society has reached a stage where it is more critical than ever to educate people in the traditional values of their culture and religion. In recent years there

has been considerable discussion about whether it is the responsibility of schools to impart values education. There is growing pressure for all teachers to become teachers of values, through modelling, discussing and critiquing values-related issues.

There are many opportunities to teach the principles of values education through existing subjects and topics. The purpose of this study is to suggest one of the many ways in which values education can be incorporated into existing mathematics curricula and approaches to teaching mathematics. In particular, it will focus on ways in which values education can be enhanced by utilizing a problem-solving approach to teaching mathematics. “Problem Solving Approach” was identified as the “Japanese teaching approach” when a group of researchers from TIMSS made a comparison between the teachings of a few countries involved in the study (Stigler & Hiebert, 1999). It is considered a theory of teaching for the subject of Mathematics in inculcating self-learning for Japanese school children (Isoda, 2010) which include learning how to learn

This study was administered at the International Islamic School (IIS) near IIUM. Since the principal investigator is a member of the School advisory panel for IIUM Lower Education Group (ILES), for the subject of Mathematics and Science. She feels the need to implement this and make the teachers of Mathematics especially, good teachers who can bring the name of IIS to a higher level and make the school an enviable international school on the same par as other well-established International schools.

This research study has the following objectives to achieve:

1. To investigate the impact of teaching via problem solving improve students’ mathematical knowledge and skills.
2. To inculcate positive values in the students of this study via the problem solving approach in the teaching and learning of mathematics.
3. To examine the impact of inculcating values via the problem solving approach in the teaching and learning of mathematics to the students.

The inculcation of values can be considered very important at this age and time. Since children spent much of their time at school, it should be a place that supports families’ and communities’ efforts to establish strong values in students. Inculcation of values could be done across the curriculum, but not much in the subject of mathematics yet. However, since mathematics deals with everyday life, it is an appropriate subject to incorporate values in. This study uses the lesson study approach to help teachers in their instructional design of lessons so that meaningful lessons could be produced, in order to ensure effective lessons are planned and developed. This study uses the qualitative design in order to collect and analyse

its data. Classes from Primary 4 and primary 5 of International Islamic School would be purposefully sampled in order to administer the study. The main researcher happen to be a member of the School advisory panel for IIUM Lower Education Group (ILES), for the subject of Mathematics and would consider this as one of her duties to enhance teachers skills in teaching mathematics. This can be considered as a continuous professional development for the teachers. Lesson study has been an effective teacher professional development and it has been practiced in Japan for 139 years in tandem with the problem solving approach. Lesson study was attributed as one of the reason for the high achievement of the Japanese students. This study would apply the problem solving approach of teaching and explore the changes that ensued. The main outcome would be meaningful lessons that can be emulated, and changes in students' values and problem solving power. Teachers will also come out of this study with more understanding of the curriculum after being exposed to collaborative lesson planning.

Research Questions

The following research questions will guide the study:

1. Do students improve their mathematical knowledge through learning via problem solving?
2. What changes in terms of values do students perceive?
3. Does problem solving method of teaching influence students' values and morality?

METHODOLOGY:

Design of study

The design of the study conducted was the pre-experimental design where treatment was applied between the pre and post-tests. Students were tested on their knowledge of each topic before every lesson of the topic was conducted. Then, by the end of the study, a post test for all four topics was conducted. The data collected was a mix of quantitative and qualitative data. The quantitative data was collected through tests, observation checklist and questionnaire while the qualitative data was collected through interviews and field notes.

Sample

The sample for this study consists of 35 year 4 students from IIS, Gombak. These students sat for pre and post-test, before and after 4 intervention lessons respectively which take about 4 months to complete. For the one-to-one interview, eight students were chosen randomly from the thirty five students to examine in depth, their feelings and opinion about the intervention lessons.

Instrument

Several instruments were designed especially for this research, in order to make sure that all important data are collected.

Pretest and Posttest – The pretest and posttest was devised to examine students' knowledge of the four topics specified in Table 1, before they learn this topic in the class. Each topic consists of four to five short answer questions. Meanwhile the posttest was developed parallel to the pretest, so that it can be used to determine the amount of learning that the student have acquired.

Observation checklist – The observation checklist as meant to be used by the observers to observe students behaviour during the problem solving time. It was designed to monitor students' problem solving framework components emphasized in the research, which consist of thinking and reasoning, communication, attitude and collaboration in Figure 1. Each component consists of six items and each item describes a desired behaviour or values of a student during the problem-solving time and sample items are shown in Table 2. Observers are required to circle any number from 1 to 5 where 1 = 'not at all', 2 = 'low', 3 = 'moderate', 4 = 'high' and 5 = 'very high' behaviour. After each of the statement, a space is provided for observers' comments.

Questionnaire – A questionnaire was designed to gather students' perception of how they perform in the problem solving class during intervention time. Their perception was collected after the intervention was over. Students are supposed to circle numbers from 1 to 5 where 1 = "strongly disagree, 2 = 'disagree', 3 = 'neutral', 4 = 'agree' and 5 = 'strongly agree' and were guided by the teacher to complete the questionnaire. The sample items are shown in Table 2.

Interview Protocol – An interview protocol, which consists of 9 questions was prepared for students' interview in order to inquire students' feeling about the intervention classes. Among the questions asked were whether they think the intervention has help them in learning about mathematics as well as whether they have developed a good attitude after discussing about values in the problems posed. Three male and three female students of were selected for interview.

Table 2: Components of problem solving in the checklist and questionnaire and their sample items

Problem-solving Components	Checklist Sample items	Questionnaire Sample Item
Thinking and reasoning	<ol style="list-style-type: none"> 1. Able to find systematic solutions to problem. 2. Attempts to select information and develop ideas to the task given 3. Interpret and critically evaluate the task. 	<ol style="list-style-type: none"> 1. I can find the best solution method. 2. I understand more about the concept. 3. I easily gather the information to solve the task given
Communication	<ol style="list-style-type: none"> 1. Communicate ideas to the whole class and with each other 2. Discuss things related to the topic. 3. Display confidence while presenting 	<ol style="list-style-type: none"> 1. I can discuss the topic well together with my friends 2. I listen when others talk 3. I do my presentation confidently
Attitude	<ol style="list-style-type: none"> 1. Obey the rules and regulation in class. 2. Pay attention and focus consistently 3. Respect other group members 	<ol style="list-style-type: none"> 1. I Obey the rules and regulation in class 2. I accept my friends' idea and answer 3. I respect other group members.
Collaboration	<ol style="list-style-type: none"> 1. Participate in setting ground rules for group work. 2. Take roles and share responsibilities as a group member. 3. Cooperate in building on ideas of others. 	<ol style="list-style-type: none"> 1. I participate in group work 2. I respect my friends' opinions 3. I cooperate with my friend to complete our task.

Quality Criteria

Certain measures were taken to ensure the reliability and validity of the data collected. First, the project took about one year from the inception until the end of the intervention period, which is enough time for material preparation and intervention to satisfy the criteria of prolonged engagement with the teachers and students. The questionnaire and observation checklist was tested for reliability and the Cronbach's alphas were 0.71 and 0.86 respectively, which are acceptable. Content validity was maintained by three different lecturers from the Kulliyah of Education, who checked the content suitability of each instrument. The two instruments together with the tests and the interview protocol were pilot tested to ensure their suitability and usability. The qualitative data also went through some processes to establish credibility criteria such as triangulation, member checking, peer debriefing and negative case analysis (Lincoln & Guba, 1985).

Classroom Chain of Events

Lesson plans were written by the two teachers involved in the study, and then checked by the researchers. The class usually starts with a short recall of previous lessons and then with the problem of the day, which was handed out in the form of a worksheet. Questions were posed

in the worksheet to guide students' learning and focus (see Appendix for sample worksheet). The different values highlighted in each lesson was chosen depending on the suitability of the mathematics topic. Table 3 shows the lesson number, topics and values highlighted in each lesson. Students were given about thirty minutes to discuss and complete the worksheet collaboratively in groups. This is followed by presentation of solution as well as whole class discussion, moderated by the class teacher. To clarify the classroom experience that the students go through, Lesson 4 will be narrated via the vignette below. Narrative has become a way of providing educators and researchers with special access to understanding the teaching and learning process (Casey, 1995). This narrative was transcribed based on the researchers' notes and confirmed by the videotaped version of the lesson.

Table 3: Lesson number, topic and values highlighted in each lesson.

Lesson No.	Topic	Values
1	Measurement: Time (adding and subtracting)	Punctuality, meaningful routines and <u>barokah</u> , <u>adab</u> , prayers.
2	Measurement: Distance (Estimation)	<u>Amanah</u> , making good judgement and decision
3	Bar Graphs	Financial Planning, water conservation, spending time beneficially
4	Area and Perimeter	Care for Environment - Composting, cleanliness, optimization (saving).

Narrative (A snapshot of Lesson 4)

It was Tuesday, 28th of March, 2017. The class was scheduled at 10.00 – 11.00 am. Students were coming from two different classes, hence they took more than five minutes to settle down with constant reminders from the teachers to get ready to start. Wow... they can really talk. The students were seated in six different groups of about five and six students each. Finally, the teacher began the class with a few quick questions on how to find perimeter and area of a rectangle. A few students answered and the teachers were satisfied with their answers.

The teachers then quickly distributed 24 pieces of sponge measuring 10cm by 5 cm by 5 cm for each group of students, to be use as manipulatives (teaching aids) in solving the problem of the day. Then the worksheets were distributed. The teachers asked the students to read the problem quietly. After 5 minutes, the students take turns to read the problem aloud and was asked by the teacher if they understand it. Some students asked the meaning of

compost and organic and the teacher invited other students to give their answers while she guided the students by interjecting once a while. Then the students were asked to work on the problem.

Each group started to arrange the sponge into rectangular shapes. There were many different ways (i.e. some even joined the sponges lengthwise or breadthwise) and at the same time trying to answer the questions in the worksheet. Some groups seemed to forget that the problem asks for maximum area. One student asked which area they should calculate, the inner area or the outer area. To make it consistent, the teacher decided to ask the students to calculate the outer area after some discussion with the researchers. After twenty minutes, the students were asked to present their group's answers in front.

During presentation, students showed how they found the dimensions of their compost plot. The answers given by each group are in Table 4. Only 1 group was able to give the dimensions that will produce the largest area for the plot. Two groups gave the same answer because it was as in the picture shown in the worksheet. The teacher then arranged the answers in a table and asked them to observe and comment on the pattern. Students observed and stated that the more the rectangle resembles a square, the larger the area. Hence the largest area is when the plot is a square.

They then discuss about composting, which led to the importance of preserving the environment and the role of each individual in making the world a more livable place. This led to their role as a student in keeping the environment clean especially at school. The class ended with everybody pledging to do their best in preserving the environment and in a small part, at least keeping their classroom clean

Interpretive commentary

Students in this class are active and can be bored or lost interest in learning if the lesson is not interesting or challenging. The problem of the day is both interesting and challenging to gain their attention and interest. Problem is open enough for students to come up with many answers. However, to be able to come up with these kind of problems, teachers need to read and surf the internet to be exposed and acquire some ideas on how to design suitable tasks for the lesson. Once they are used to it, then it will come naturally. In this case, the researchers help the teacher to design the problem. Hence, due to it not being an original idea, from the teachers, it was observed that the teachers was not able to guide the students well enough, as can be seen from their hesitation in many instances that need quick decision and clarification.

Table 4: Students' answers for area and perimeter according to group.

Group No.	Dimension (Length x Breadth)	Area	Perimeter
1	105 cm x 25cm	2625 cm ²	260 cm
2	85 cm x 45 cm	3825 cm ²	260 cm
3	95 cm x 35 cm	3225 cm ²	260 cm
4	105 cm x 25 cm	2625 cm ²	260 cm
5	65 cm x 65 cm	4225 cm ²	260 cm
6	75 cm x 55 cm	4125 cm ²	260 cm

This research skipped the lesson study part of the framework, as was mentioned earlier due to time constraint and not so encouraging number of teachers who participated. It is important to include lesson study because lesson study also act as a professional development programme²³, which in turn upgrades teachers' pedagogical content knowledge.

Research Objective	Data Type	Data Collection Strategy	Validity	Data Analysis
To inculcate positive values in the students of this study via the problem solving approach in the teaching and learning of mathematics.	qualitative	Video recording Observation Field note Checklist	Triangulation Member check Prolonged engagement	Theme Searching
To examine the impact of inculcating values via the problem solving approach in the teaching and learning of mathematics to the teachers and students.	qualitative	Video recording Observation Field note Checklist	Triangulation Member check	Theme searching
To investigate the impact of lesson study as a professional development to the teachers.	qualitative	Observation Interview Field notes Checklist	Triangulation Member Check Prolonged engagement	Theme searching

FINDINGS:

The findings will be presented based on the research questions stated above.

Answering Research Question 1 – whether students improve their scores in mathematics by learning via problem solving. This question will be answered using data from the post and pre test.

Table 5: Paired sample t-test for pre and post test

Paired Samples Statistics				
	Mean	N	Std. Dev.	Std. Error Mean
percentpre	79.900	35	10.606	1.793
percentpost	85.143	35	21.638	3.657

Paired Samples Test							
	Paired Differences				df	Sig. (2-tailed)	
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference			
				Lower	Upper		
percentpre - percentpost	-5.243	24.064	4.068	-13.509	3.023	34	.206

The data above show that students scored a mean of 79.9 in the pretest and 85.143 in the posttest. It can be observed that students improve by 5.243%, which is however, not statistically significant.

Answering Research Question 2 – whether there is any change in terms of perceived values gained by the students, and this question will be answered through students’ written answers and interview to related questions, as well as observation of classroom episodes. Data from students’ written answers and interview were analyzed and emerging themes were noted as in Table 6

Table 6: The questions asked for students to answer in written form and the themes that emerged

	Questions	Themes
1	Why do we need to respect other people?	Islamic reasons, mutual respect, good thing to do
2	Why do you need to help your mother?	Islamic reasons, mutual help/repay, natural thing to do
3	Why do we need to save money?	Islamic reasons / cannot waste, for other things/for future,
4	Why would you choose the shortest possible way to go anywhere?	Save time and money, best & more efficient way

From the analysis of the interview transcription, two or three emerging themes were extracted from each questions. About half of the students respect other people because of Islamic reasons – because Allah and the prophet encourage it or because they want to get the reward from Allah. Others said that it is a mutual thing to do – if we respect other people, then they will respect us in return. Then there are some (not that many) who said that respecting people is just something good and should naturally be practiced. As to why they help their mother, there are a few who gave reasons because they want reward from Allah, while about half said that since their mothers have work hard for them, gave birth to them, then they should help their mothers (repaying her good deeds). Many also said that helping their mother is a natural thing since they love her – so that she can rest since she works too hard. A few also said that another reason is simply because she is their mother. As to the question why they save money – some gave Islamic reasons such as for *zakat* and *sadaqah*, many said that they save for the future – to buy more important things or to use it when they need the money. The theme about saving money is also evident in the answers to question 4 where most of the students say that they will take the shortest way to save time and money on fuel, etc. A few answered that it is the best and most efficient way unless the shortest route is flooded or under repair – so that they can reach their destination early and have more time to do other things, such as spending time with family.

Subsequently, the in-class observation also shows that, teasing between students is less as compared to the beginning of the study. Students were also more serious and pay more attention to their classwork. Their manners also improved during the class discussion – i.e. they listen and consider their friends' ideas and opinions attentively.

Answering Research Question 3 – whether problem solving improve students' values and morality. This will be answered using data from the questionnaire, observation and interview.

Table 6 shows the mean score for each component of problem solving that was emphasized during teaching in order to improve students' values and morality.

Table 7: Mean and SD for the questionnaire and final observation data

	Questionnaire Data		Observation Data	
	Mean	Std. Dev.	Mean	Std. Dev.
meanTAR	3.992	.6341	3.335	.6123
meanCOM	3.910	.6997	3.211	.5145
meanATT	4.192	.7804	3.322	.6565
meanCOLL	4.092	.8295	3.425	.7125
Overall	4.045	1.13	3.323	.6243

Overall, the questionnaire score is around 4 which shows the student agree that the lessons have improved their thinking and reasoning, communication, attitude and collaboration skills, which are considered as main characteristics for the success of improving students' values through problem solving. Upon closer inspection, it was found that students scored high (between 4.15 to 4.30) in being able to get the information and develop ideas to the task given, listen when others talk, pay attention and focus consistently and participate in group work for the domains of thinking and reasoning, communication, attitude and collaboration respectively. The observation data shows lower scores given by the observers. The mean scores are around 3.3 which are moderate levels of thinking and reasoning, communication, attitude and collaboration exhibited by the students. The emerging themes from the interview data are presented in Table 8.

Table 8: The emerging themes from the interview

Themes	Sub-Themes
Like the way the lessons were conducted	Class environment is different - group activity is fun and cool, feels like 1 st day of school because of combined class.
Change view on problem solving - positive	Like collaborating with other students Like the presentation part.
Increased mathematics knowledge	Understand lesson better – conceptual understanding,
Improve problem solving skills	Especially thinking, because of working in groups, reasoning, attitude and collaboration, group discussion, work together and share knowledge.
Improve moral values	Can differentiate between good or bad, can observe own behaviour in daily activities, learn to be better especially about respect
Learning method	Exciting, not sleepy, understand more, start to love maths, like to do project, know students from other class, know each other better, parents notice some change of attitude and learning skills

The interview data which was intended to support the two kinds of data above was transcribed and classified according to the emerging themes. Overall, students agree that they prefer learning through problem solving in a collaborative way. The tasks have made them think more about values and morality, about how to behave and to be always be ready to do their part in any circumstances. They have learnt to accept their friends' ideas and suggestions, conduct in good manners when collaborating and discussing with their friends, learn to value their friends' effort. Some of their parents have notice the change in them – they are more helpful at home and are more obedient.

DISCUSSION AND CONCLUSION

This whole study had produce mixed outcomes as findings. Firstly, when the post and pre-test scores were compared, the gains in the post test were not high enough to be significant. Students seemed to know the topics well even during the pre-test since they already scored about 80% in pre-test. Hence, the increase was not that high. On the other hand, the data from written answers on values, interview and observation seemed to indicate that students learnt about values in the classroom.

Their written answers and interview seemed to indicate that they are aware of getting rewarded by Allah if they do good deeds. Besides that, they seemed to be aware that respect is mutual – someone should show respect if he wants to be respected. The answer to the second question indicated that they also help their mothers because their mothers have done a lot for them and it is part of their duty to reciprocate. What is more encouraging are answers that show them respecting others and helping their mothers because it is the right thing to do, without them thinking of themselves in the equation, which shows maturity and high level of *iman* on. The Islamic reasons were also evident in their answer to the rest of the questions where saving money and not wasting is encouraged in Islam and the extra money can be turned into *zakat* or *sadaqah*. The savings can also be used for future or other useful things, according to some of them. They would also find the most efficient or shortest route in order to save money and time, which are all good Islamic values.

Observation during the lessons shows that students gave good answer and ideas during the discussion about some moral situations such as about punctuality, *amanah*, cleanliness, care for the environment, etc. It will be interesting to find out if they will still feel this way and exhibit this in the form of action after six month of the date the research ended.

On the issue of whether problem solving method as adopted in this study improved students learning of values or morality, it can be implied that the data, (especially the interview data) seem to show some connection. In general, students agree that the lessons do contain the

elements of problem solving shown in the framework, while the observers rated students slightly better than the moderate level in terms of their behaviour in the components of problem solving. The interview data seemed to confirm that students learned about values through problem solving and at the same time learn about mathematics and problem solving. Most of the students interviewed agree that they like the discussion on values in the problem presented. According to them, the discussion has made them think better for them to reflect on the right way to behave in the situations post by the problem. They all wish that they have more time for the discussion.

The study showed that any attempt to inculcate values across the curriculum should be encouraged. However, the teacher factor is very important in the success of such study. Teacher needs to look for interesting, challenging and stimulating problems to make it into suitable problems of the day. The problems chosen needs to be discussed, looked at from different angles and planned very well in advance. The earlier problem presented especially in Lesson 1 emphasize more on Islamic rituals rather than universal values. Basic values connected to importance of cleanliness and preserving the environment were only dealt with in the last lesson after several requests from the researchers. The inability of the study to incorporate lesson study as teachers' professional development platform has made it not quite successful in terms of teachers' planning and implementation of the lesson. There were weaknesses in this study regarding teachers' pedagogical content knowledge, which can be addressed by lesson study²⁵. The cooperation and commitment of all parties especially the school administrators and teachers is also important for the success of lesson study or any study of this nature, since the knowledgeable other (which is important in lesson study) will be present to guide the implementation of the curriculum²⁶.

Teachers' values that are espoused during their mathematics teaching have a powerful influence (negative or positive) on students' affect. Hence it is also important for the research of this nature to look for teachers with positive values. Other recommendations for future research would be for the school to include 'lesson study' emphasizing on values as their main theme, in their school calendar. Another suggestion is for the teachers to employ philosophy for children²⁸ method of teaching for value inculcation in mathematics problem solving. By this, *Insyah Allah*, education will be more meaningful and hence produce enviable *ummah* with Islamic manners. If the whole Muslim population presented themselves in this manner, then the reputation of a Muslim would be far too virtuous to allow the misdeeds of a few to tarnish the image of other Muslims.

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Future Plan of the research: Insya Allah I will lead the KOED team to have a school base lesson study to help the teachers in writing a meaningful lesson since this particular study was not able to implement it.