The Role of Physical Education in Developing Student Characters in the Industrial Revolution 4.0

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Abstract. The physics paradigm includes symmetry, optimization and unification is a unity of human life. The paradigm contributes to the development of physics education, so it has a role in providing a frame of reference in the development of good character students. Three aspects of physics education that affect human nature include (a) habits and explorative abilities of the surrounding natural environment; (b) communication and mathematical representation in step for problem solving; and (c) habit in developing problem-solving using observation and experiment tools as well as manual or digital information processing. By linking these three aspects through implementation to the learning process in the classroom and based on honesty and goodwill of individuals, students can build products to think towards good character. Rational considerations by physics thinking, always trying to be grateful and patient in every step of life by students, have a role in personal development with noble character.

1. Introduction
Today, if we reflect on our duties as teachers, we must honestly admit that the products and processes of education in Indonesia have good and bad sides. The good side marked quantitatively has been many successful teacher delivering students to reach their dreams, but qualitatively often the results achieved in their assignments are still considered to be of concern. For example, the teacher's response in 21st century learning ideas released by the UNESCO education commission which emphasizes continuing education by building more meaningful competencies and skills in human life. As lecturers in collage, we need to improve competencies to survive in the current era, especially with the emergence of the rapid development of technology and information (ICT) in the 4th revolution era. Today we need 5 (five) skills; complex problem solving, critical thinking, creativity, people management skills and collaboration that interesting things to study and respond to in our daily tasks. For policy makers these five demands need to be anticipated, especially policies relating to implementation of learning. One aspect that needs attention for policy makers is the provision of a good environment for learning. Students can master physical material by synthesizing and evaluating information from various sources, while still relying on aspects of local wisdom in the environment in which students live.

According to the description above about learning physics that should not be forgotten is the mastery of the 'dimension' of physics, the pillars of scientific thinking. The two main pillars that always form the basis of physics development are ‘observation’ and ‘obedient thinking principle’. Through these two
pillars we are able to obtain truth, confidence in acting and making decisions about what actions need to be taken through studying physics. These two pillars can be implemented in various learning models. Then does the reflection on the implementation of the task as a teacher focused on ask yourself; has referred to the development of student character?

The deterioration in the quality of education is indicated by the poor character of students which is often an interesting study because of the failure that always exists without solution. Complaints to state and private college because of the low quality of graduate competencies. Today with open information, it can be a reflection of awareness to change and improve itself. Studies related to education processes and products show that the deterioration of character occurs in our country 'not only' in Physics education, but also in almost all aspects of life. As an illustration, violations of the rule of law, corruption, collusion and nepotism (KKN), violation traffic law discipline, violation of employee working hours, violation of youth and parent interaction, destroying of institutions facilities that provide services public education, others that indicate the low quality of these characters.

The low quality of education can be influenced by sociological, historical, personal, philosophical / religious, logical and empirical and aesthetic factors. Sociological factors are things that originate from the structure and social system that refers to the original environment. Historical factors are related to aspects of human history, which in each space and time should be able to provide awareness about personal self-wisdom and human character. Logical and empirical factors are pillars of thinking in physics that need to be trained in students, the ultimate goal is that students can understand and appreciate the phenomena of physics and apply in solving life problems. Aesthetic is a matter relating to beauty, namely harmonious relations as an embodiment of understanding aspects of art. Furthermore, philosophical aspects come from the order of life and universally religious life that is reached through mental exercise with the depth of thought and appreciation of religious life. Some of these factors can also be classified into internal factors and external factors, all of which should be reflected and lead to solving the problem of the current low education process and products.

Referring to the behavior of nature for centuries, that is, since humans are on earth always follow the creator, God. By the will of God, the universe can be enjoyed by humans with all its temperament. There are some who care, but there are others who do not care. However, events in the universe are always orderly, both for those who treat well or not, and the universe has not experienced a single lameness because it was created by one hand, that is God. To the behavior of this universe there are some people who care, want know about these natural events but most of the others don't care about each other. For a group of people who care about this natural phenomenon, it starts with curiosity so that they always try to live and understand the regular pattern of natural phenomena; which subsequently is able to state the rules in its systematic notes; and communicating to other people or colleagues who are curious.

The next stage will be a continuous appreciation of the observers and users of natural phenomena. In the history of physics, this attempt to communicate the rules called natural law; researchers of natural phenomena are bound by moral rules of honesty. Natural law is not the same as the understanding of law that is generally understood, because natural law is essentially God's law revealed by scientists, the owner of law remains in the hands of Almighty God, so the validity of natural law is often eternal. Only the discovery of a new law can change the old law that was discovered before.

Knowledge of the history of physics can explain that physics and its methods have become important tools for the development of human thought, so that until now physics is one of the scientific knowledges that has existed since approximately 4 centuries ago. So, it is proper that physics is often used as one of the common knowledges that becomes the moral and intellectual character of humans. Humans will not be able to live without reacting to their environment, so humans have the characteristics of attitudes and high values always try to explore the environment in ways that are able to save humans on this earth. Thus, the natural environment as a gift of God needs to be used wisely and wisely in line with sunatullah.

The results of thought and findings by observers provide a model that the struggle of physicists for human life and glory that lasted from the past until now, has become a basis for thinking, can be lived, understood and utilized for human life and life on earth. This can be further utilized for the development of human character, scientific attitudes and scientific methods for the next generation. Following in
Table 1 shows the comparative exposure between the 4 stages of the physical revolution and the industrial revolution.

**Table 1. Comparison between the 4 stages of the Physical Revolution and the Industrial Revolution**

| No | The Thought Revolution of Physics [1] | Industrial Revolution [2] |
|----|--------------------------------------|---------------------------|
| 1  | The first revolution, The revolution of thought began in the XVII century, known as the era of classical physics with figures such as Newton, Bernoulli, Euler, Laplace, Lagrange, etc., which was marked by the study of gravity and the dynamics of celestial motion. Physics is known as an exact science; all macro phenomena can be predicted. | The first revolution was marked by replacing industrial devices based on human labor with the invention of steam engines and industrial mechanization. This revolution took place in the 1800s as a way to replace human labor. This revolution is given the mark of the 1.0 industrial revolution. |
| 2  | The second revolution, pioneered by Maxwell based on the discovery of Coulomb, Biot Savart and Faraday, was able to explain the electrical and radiation properties carried out at a laboratory scale, the impact of the discovery of electromagnetic waves was able to encourage the growth of the electronics and radiation industries. | The second industrial revolution took place about a hundred years later, with a long, continuous, structured and dynamic process to make it convenience for humans by being characterized by the invention of electricity and producing production with assembly line production that began in the automobile assembly industry which previously done by technicians at each station whose location is different from a conveyor system that began to take place in the 19th century, was categorized as industrial revolution 2.0. (Pioneer by Henry Ford) |
| 3  | The third revolution, beginning in XX, start from study of the nature of matter and the universe through laboratory activities. The findings are well known among those made by Einstein, Planck, Schrodinger, Heisenberg and Dirac, etc. are considered to be the peak of human thinking about nature. The use of imaginary numbers in physics solutions is driving the revolution of human thought towards the universe. They are trying to find the structure of the atom through quantum phenomena whose studies differ from previous studies. Related to classical physics the principle of correspondence has been formulated. | The complexity of the industrial revolution took place around the 1970s with the stage of partial automation by utilizing controllers that could be programmed as well as the use of computers. With the help of a programmed robot that is able to automate a portion of the production process in the company which further impacts on human lifestyles in society. This stage is often referred to as the 3.0 industrial revolution. |
| 4  | The fourth revolution, marked by the discovery of micro particles by large and sophisticated equipment. These findings are a booster of physics in advanced era. | Optimizing computer technology with the use of an internet network connection enables communication between components in an industry. Five outstanding technologies; computing hardware, production hardware, software, and its interface and connectivity devices |

Table 1 provides an illustration of the compatibility between the development of physics as a way of thinking about natural issues and their application to the industrial revolution. The interesting thing in the implementation of physics with its application initially took place in a long / long deadline became increasingly fast / shorter, and even now it is difficult to separate between the two.

Physics education is a scientific discipline that utilizes physics as a means of student development. This discipline clearly integrates physics on the one hand and various studies of educational theory on
the other. Physics with its dimensions and paradigms can be built on the history of physics, learning psychology and teacher mastery of students both about how to think, behave and act as part of the principles that should underlie practice in the classroom. Physical physics is related to the implementation of empirical aspects and rational thinking, while the physics paradigm relates to aspects of the implementation of symmetry of optimization and unification. In this connection physics education can provide the basis for the development of the physics curriculum and be implemented in various educational institutions. Physics ability refers to how physics can be explored and developed through the means of thinking that is owned. Understanding the attitude associated with a true appreciation for the creation of God.

In an effort to explore and develop these in addition to paying attention to the subject matter of physics also needs to pay attention to the humanities so that humans avoid intellectual and cultural separation. Intellectual separation is related to behavior that deviates from the culture in the environment. This is intended so that physics education can be built into a chain of synergism between mastering physics and its application in technology with a high sensitivity to humanity. So, physics education can be built a balance between the daily habits of student life with scientific culture, which is a culture that is able to combine humanities with physics and technology.

Based on the description above, the curriculum and the development of good character of students are partly in line with aspects that develop in physics. Therefore, in an effort to improve physics education in schools, as a prerequisite is the mastery of the fabric of scientific culture with the concept of *akhalqul karimah*. The scientific culture in physics includes the emergence of positive perceptions of the potential of individuals which can lead to predictive abilities. This predictive ability is focused on the ability to predict future conditions, which is an effort to build a broad view, thoughts, attitudes and actions that are able to support the work environment to always anticipate events in the future. The question that arises next is how is the role of physics education in developing the character of students who have morality in the era of the industrial revolution 4.0?

Dwi Sulisworo [3] states that digital literacy between teachers and students is no different for both urban and rural areas, so learning in this digital era is important to be implemented in schools. Although from the results of the interim observations it appears that the optimism of digital-based learning is more pronounced in the urban environment, which is marked by the government's efforts in initiating applications and related policies. With the level of ICT penetration, especially with the implementation of computer-based national exams it is assumed that the distribution is evenly distributed in Indonesia. So, the success in the mission and vision of physics education needs to be based on how high the physics dimension and paradigm play a role in improving the quality of developers and users.

2. Characteristics of Physics Education and Its Implementation

The development of individual character aspects that need attention is the integration between the dimensions of knowledge, attitudes and skills. The dimension of knowledge is related to mastering the physical aspects and human aspects, both of which are often dynamic, the changes that occur are related to time and place conditions. Attitude aspects are focused on habituation efforts namely preserving positive and good attitude responses, so that when humans face problems they always have spontaneous responses, with good prejudice. Skills aspects in physics are always related to intellectual skills and physical skills. With high digital literacy intellectual skills is a skill in solving complex problems by integrating empirical and rational aspects. Physical skills related to the utilization of the senses of the body in completing tasks that are physical. Integration between knowledge, attitudes and skills in physics can support in mastering science and technology.

To respond to the progress of science and technology, can be found intellectual and cultural separation. Intellectual separation can produce attitudes of students who are anti or provide negative resistance to face advances science and technology. This is indicated by the negative value of the use ICTs in solving problems. Then cultural separation is a behavior that deviates from the cultural order and norms in the environment where individuals associate and socialize. So, both of these separations
need to be eliminated so that physics education can be built by mastering physics and technology in line with human values. So, physics education can be built a balance between daily living habits with scientific culture, integration of values that are able to combine humanities with physics and technology.

Cultural culture in physics includes 6 aspects, (1) curiosity, (2) cooperation, (3) reproducibility, (4) consistent reasoning, (5) open, and (6) observable [4]. curiosity is actually a basic human instinct, but in physics education curiosity is shown as a desire to always explore knowledge by looking for new things that have not been explored and are expected to be useful for others. By ICT, physics education can trigger the curiosity of students, so that aspects of critical thinking and creativity of students can be developed. With this creative ability and critical thinking, it is hoped that good character can grow. That is because natural phenomena are unique so that they are made linear models; there is a connection between things that have been studied - are being studied - have not been studied. The aspect of cooperation has been pioneered for a long time, because physics is built together by many people. This aspect is related to the era of modern globalization requires the ability of humans to work together synergistically, in other words everyone can use the work of others as a foundation for development without restrictions, as long as it ethical.

Mention of references in each scientific work is a way to give credit to other people's work. The availability of the internet allows for such collaboration to take place synergistically and broadly. So future collaboration does not always have to get together and solve things together, but can be done in various ways by internet access. In this connection, the domicile of a person may be in a different place and have never even met, but a collaborative culture of cooperation can be built. This has been going on in physics for a long time.

Reproducible, is a part related to human limitations in understanding natural phenomena but human excellence in making research. Physics studies generally rely on these reproducible natural phenomena, namely that anyone who studies natural phenomena if they follow established rules will naturally obtain the same results. This is where everyone will be trained not to lie in communicating the results of the study, because the findings are very open for anyone to re-test with results that are not different.

A consistent way of reasoning is a form of obedient reasoning, all-natural phenomena need to be explored and developed from a natural phenomenon that is unquestionably correct. Reasoning in physics which obeys this principle can develop well so the role of mathematics can influence its findings. Included in Revolution 4.0, the role of mathematics is important. The era of the industrial revolution 4.0 is described as the proverb 'nglurug tanpa bala, menang datan angsorake’. It means that through mathematical sentences, all findings can be made predictive, decisive, conccise, clear, concise, do not always tend to involve emotions, feelings of the author and allow to be re-tested with results are no different. Things that appears next is an open attitude, findings in physics are very open to be examined with a different perspective, so physics is not a doctrinal science. This fact has been proven in the history of the development of physics that gave rise to the revolution of physics thought.

For example, the theory of light developed by Newton does not differ greatly from Huygens, nor does relativity according to Newton and Einstein, both complement each other. The truth of both theories will be decided by the results of observations that match, so the final truth is their compatibility with the results of observations. The explanation above is the embryo of the principle of complexity and correspondence in quantum mechanics which shows the authoritarian physics.

Next, the understanding of the nature of physics education is based on the specific embodiment of physics itself which starts from the attempt to obtain a culture of truth called systematic thinking by physics which is characterized by humanity. Some specific characteristics of the nature of physics education include (a) habits and explorative abilities of the surrounding natural environment that maintain its sustainability; (b) forms of communication and mathematical representation in every step of thinking for problem solving; (c) habits in developing problem-solving techniques using observation and experimentation tools and information processing [4].

Aspects of physical skills that are widely used as a way of solving life problems in their interactions with the surrounding natural environment include aspects of (a) description, (b) explaining, (c) prediction, (d) control and (e) recognition [5]. These five aspects are often used as indicators of scientific
culture which generally determine the character and degree of individual intellectuality based on the mastery of natural law well. For example, students' mastery of Newton's law, conservation of energy, conservation of momentum, mass, charge, and Einstein's relativity and so on. This Scientific Culture should be associated with humanity. Through physics education can reach the substance of scientific culture towards a comprehensive reach, a degree of intellectuality that understands natural laws well and has a high concern for humanity.

3. Symmetry, Optimization and Unification and Its Implications

Three physics paradigms in the development of physics are symmetry, optimization and unification [5]. Symmetry is defined as an unchanging trait if a system is subjected to a transformation operation. Symmetry directs physics to efforts to find a match between predictions and results obtained through the measurement of natural phenomena. Every discovery of physics as a 'judge' is a natural reality. The implication of this paradigm is that every physics learning should be based on the measurement of natural phenomena using a calibrated tool. In measuring natural phenomena every student should use a measuring instrument that has been calibrated. In connection with the character load of symmetry students are described as "curiga manjing ing warongko", with the intention of fitting there is a match. Physics needs to be directed at efforts to get a match in terms of gaining how to get to the truth, how it fits and how well, so as to be able to develop multivalent among the students.

The impact of this symmetry is the power of physics on quantitative aspects, measurement, honesty, accuracy, accuracy and limitations. The effect of character development is shown as the strength of physics, train the ability to think, self-confidence on the limitations and strengths, strong characters, be careful in making decisions, honest and always consider aspects of the heart and mind.

Optimization is defined as an effort to choose the best with the basic principles of mathematical accuracy and accuracy. The use of extreme approaches and variational methods becomes a means of thinking physics. With optimization, it can be selected and determined the shortest time and action with the smallest risk in solving physical problems. The introduction of geometric shapes based on the principle of optimization should be the main emphasis in learning physics. The implication of this paradigm is the nature of sunatullah's behavior, according to God's will as the ruler of the universe. Natural behavior that is amazing but always contains order so as to arouse curiosity and cooperation between people. Each physics finding will challenge the next finding, which has an impact on human behavior to be patient and grateful.

Unification is a way of applying the laws of physics to a group of phenomena against a background of integrated ideas. So whatever effort is made in class, by learning physics correctly the ultimate goal is to gain the benefits of increasing life skills and obtaining truth. By this unification can be obtained the truth that is reached through physics can be brought closer to the empirical, rational, probabilistic and relativistic aspects. The impact that is in line is that people will realize that behind good side, there is a bad side.

Humans try to obtain convenience by managing and utilizing God's created universe. Then the various abilities that can be developed through physics learning are (a). Making the concept of tools that can provide convenience to humans. (b) living and experiencing natural phenomena carefully (c). distinguishing and choosing the actions with the shortest delay that makes humans able to move forward. The means of thinking that can be used is mathematical logic, language logic, statistics and others.

4. Growing Good Character by Physics Education

Physics education in schools can be grown with exploratory habits to the environment. Three learning phases that need to be created in class are phase (1) information, (2) habilitation and (3) reflection [6]. The information phase is the systematic and applicative phase of data presentation. This aspect in the era of the industrial revolution 4.0 provides data and networks to be meaningful in human life. The habilitation phase is developed through exercises in handling data, especially in organizing all information before a decision is made. Data mining and data analysis each symptom becomes interesting to do. Furthermore, the reflection phase is the stage of using reasoning that leads to creative and critical
opinions. These three phases in learning require that future elements enter through physics learning in the classroom. Here dialogic learning, with orientation to the development of student potential is an effective means of fostering good character development for students.

As an illustration of the use of physics associated with aspects of worship is to set the direction of Qibla for Muslims which is determined referring to the direction of longitude and latitude. Referring to that the position of Makkah [7] is at 39 degrees 49 minutes east longitude (east of Greenwich) and 21 degrees 25 minutes north latitude (north of the equator). Yogyakarta's position is 110 degrees 21 minutes east longitude and 7 degrees 45 minutes south latitude, the Qibla direction is 65 degrees 17 minutes 42.79 seconds, while in Jakarta which is 106 degrees 38 minutes east longitude with 6 degrees 10 minutes south latitude the Qibla direction is 65 degrees 44 minutes 0.84 seconds. So, to evaluate aspects of the benefits of prayer movements that are useful for body health, the role of mechanical studies becomes a meaningful part to assess aspects of the body's balance and aspects of prayer solemnness to be stable if followed by the right Qibla direction.

By utilizing the circulation of the month, it can be determined the beginning of the Islamic month, muharam, shafar, rabiul awwal, final rabiul, rajab, sya'ban, ramadhan, syawwal, dhuqlq'adah and dzul hijjah. Another illustration of the role of physics education in fostering reasoning life is related to zakat, infaq, shodaqoh (ZIS) is the study of the scale factor and relative strength. The scale factor is a pair between two corresponding physical quantities, for example between length - by length, volume - with the corresponding volume. In social science the role of dogma between human income is human, with different nominal. Another thing is related to the relative strength of the individual in terms of ZIS if the standard of awareness, sincerity, intentions are identical / identical, then individuals who earn little and have a great intellectual value of worship do not differ. Although given in the form of ZIS have different nominal values, but the proportions are not different. Both can reach the goal of reward the hereafter which has the same value. This relationship is the way that can be taken, among others, through physics education is by problem solving, the development of learning by means of experimentation and observation, effective communication through language and mathematics. Therefore, in learning it is necessary to place students not merely as objects but as learning subjects.

The task of the teacher according to Scheider [8] is how to understand students' way of thinking about physics and make communication between students and the universe so that they can increase their gratitude for God's gift. Here are six benchmarks in making the learning atmosphere enjoyable, namely (1) strength in intention; (2) sympathy and mutual understanding; (3) cheerfulness and awe; (4). risk taking; (5) mutual ownership; and (6) example [9]. The strength of intention means that every action always depends on the intention; Good and strong intentions from a teacher will encourage good teaching behavior. In this case the confidence in the ability possessed and motivation to learn students need to be well recognized by the teacher. This introduction is certainly useful in making sympathy and mutual understanding between teachers and students. Furthermore, cheerfulness and awe are fostered by realizing that learning is a positive act, 'not by negative coercion'. The thing that students always remember is the first experience when successfully doing something, because students are said to learn when they have done something. Learning without doing something tends to be easy to forget, so the knowledge used is the correct knowledge students have. So learning is always risky, meaning that every time we try the first-time new things will be found a scary step, the risk of failure. Therefore, the sense of belonging and example plays an important role. A sense of belonging is built through communication that student success is part of the success of the teacher and vice versa.

In connection with the two pillars of physics, learning physics through observation (factual, or virtual) can develop empirical verification thinking that raises the awareness of factual thinking, while thinking obedient to the principle can bring breadth of insight; and developing high intuition. As a result, students can make meaningful decisions to accommodate the findings of other parties in a broader framework of thinking. As an illustration in the history of physics, among other findings from since Archimedes, Galileo, Faraday and Maxwell can be explained five meaningful human thinking awareness in building good character relating to aspects of awareness of (a) the existence of material symptoms and events; (b) the appearance of images, delusions and presuppositions; (c) idealization
arises from images and delusions; (d) express ideas in mathematical sentences; (e) test the truth through the formulation of language, which is in the form of natural law. These five things result in an inductive thought process that produces a patient character.

In terms of research and PKM carried out by improving the quality of the process and the results of research and PKM, especially the significance of research and PKM for efforts to grow critical and creative aspects through collaboration. In this connection the integration of tridharma and collaboration between various researchers from various scientific disciplines, the development of collaborative, collaborative research management between culture and physics developers from the time of planning until the publication of the results needs to get optimal results.

In educational institutions, the role of physics education in developing good character needs to be supported by three main pillars of the academic community including commitment, human resources and the value system adopted. Commitment according to Glickman [10] is interpreted as a tendency in a person to be actively involved with a full sense of responsibility. The definition contains three keywords, namely "effort/encouragement", "care" and "provide sufficient time". Commitment is an action in order to allocate resources that are consistent with the framework. Efforts to develop human resources based on noble morality stem from the ability to be grateful continuously and strive to live in this world as a field of charity. Both of these will be meaningful in high cognitive development. Indicators that emerge are the emergence of abstract, intuitive, imaginative, creative and rational thinking abilities so that the implementation of the tasks becomes more flexible.

Next, the value system adopted is not only referring to the value hierarchy that is compiled based on the interests of achieving the learning objectives, but also needs to be directed at efforts to instill the true creed, noble morals, and have mature thinking [11]. By mastering 3 aspects including (a) 4Cs (creativity, critical thinking, communication and collaboration), (b) ICTs (information, Media and Technology) and (c) Life and Career skills, the ability to think critically, creatively and communicationally for cooperation and responsibilities that lead to the benefit principle based on patience and reconciliation. Therefore, the value system can also be an embodiment of the form of individual self-esteem. This self-esteem is furthermore as a means of developing the ability to adapt, to get along, and to keep in touch, which is a way to survive in the era of the industrial revolution 4.0 in life in the future.

5. Conclusion
The role of physics education in character development, the level of success is marked by the appreciation of students towards science and technology, especially the progress of ICT in the revolution era 4.0. High appreciation of ICT indicators is learning needs to include aspects of students like physics, so students can appreciate learning inside and outside the classroom which leads students to have good academic ability and character. This is marked by the close relationship between science, technology and art. But all these efforts need to be returned to the nature of students as whole human beings in the form of appreciation and practice can only take place meaningfully when the 'hidayah' of God, including guidance, tauifik, 'irshad, inspiration and dhilallah. The teacher's task is to develop ways for students to be able to adapt to physics, ICT and interact with fellow students as well as the interactions between students and teachers ethically. The ways taken include habituation in acting using conscience, prioritizing aspects of the process with learning strategies, good models, consistently developing the potential of students, integrated, directed and disciplined which is supported by the availability of facilities, infrastructure that is used effectively and efficiently so as to support the improvement quality human resources with good character.

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