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Scientific instrumentation used for the evaluation of physical education and sport science

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Abstract
The purpose of this paper was to study evaluation of physical education and sport science using scientific measuring instrument in the evaluation of teaching, coaching and research work. For its simplicity the paper used descriptive approach that structured into abstract, introduction, conclusion and recommendation. It was observed that there was a limited application of evaluation by means of measuring instrument due to different factors such as resource, fund etc. at school, college and universities. Because of this limitation the predominantly functional method of evaluation at school and college level was the usual written exam and subjective judgment of physical performance. Beside Some of the needed scientific standard measuring instrument used for evaluation it was indicated Hi-tech technology, computer, GPS, video, camera and simulation system used for evaluation. However, because of the limited resource there was a gap on the application part of evaluation using instrumentation which was extremely important in sport teaching, training and competition. The paper specifies the advantage, the need, and challenges in using scientific measuring instrument in physical education and sport. Based on literature review it provide necessary measure to be taken to solve problem of evaluation using instrument. Some important points were reflected under recommendation that will very essential to the current demand of the development of sport at school, college and university level in teaching, training, competition and research work related the topic.

Keywords: instrumentation, physical education, evaluation, research

Introduction

The objective of this paper was to discuss the significant contribution of Scientific Instrument that highly crucial for evaluation in sport. The main intention is to implement scientific instrument in collecting quantitative value of the student or the athlete physical performance in the evaluation of physical education and sport. To be clear, first let us see the meaning of some key terms of this paper. As stated by Hackman, W. (2013) [8]. Scientific instrumentation was a device or tool used for scientific purposes. For the context of this material "Scientific instrumentation" stands for all standard measuring instrument used to measure human body, psychology and performance related to sport science or physical education. According to Leslie Cromwell *et al*, (1980) [12]. He describes that the objective of any instrumentation system commonly falls in to one of the following major groups.1/ Information-gathering 2/ Diagnosis 3/measurements 4/Evaluation 5/Monitoring and 6/Control. Therefore, measuring instrumentation assist information gathering for the purpose of supporting measuring objectives with standard valid facts. It also substantially supports in diagnosis or identifying the deficiency using the instrumentation as a means of evaluation or testing the measured object. Similarly, it significantly provided valid and accurate quantitative measurement value for the thing that measured for the intended purpose. Similarly, it helped to assure the quality of the variable by value judgment based on collected data from instruments in the process of evaluation. Other spectrums part of instrumentation was application of monitoring system by observing and checking the progress of the athlete like using sphygmomanometer for measuring blood pressure. Instrumentation also operate in controlling the circumstances in the state of equilibrium or within the range of limit for example, the level of exercise intensity, heart rate etc. during exercise practice in the field or in sport lab. It is very interesting to slightly touch the very common but the key concept of physical education particularly its definition that vary in many cases. For this material I prefer the definition of physical education as an education through physical activity "which embrace both development of body and mind. It must be remembered that the early smart philosopher whose belief was remain as Standard truth and till shining today "a sound mind in a sound body" by Thales Miletus, (624-546 BC). This truth not only used in health or sport it was a reference pillar of concept in all human science study in addition including spirituality situation. The concept can be observed, measured and reputable. In my view the base for the definition of physical education should anchor this fundamental concept. Evaluation of physical education lead to evaluation of both body and mind. Sport science is a science that study the effect of exercise on human body and mind. Both physical education and sport science concern on the production and development of healthy man contributing an input for sport and being a healthy citizen for the society. This topic mainly focusses how to improve the limitation of application of evaluation using scientific measuring instrument in physical education and sport science. Physical education and sport science work to achieve common goal in the area of Health, physical fitness, exercise, gymnastics, athletics, different ball games, combat sports, racket games etc. at school or college level. Shamy. S (2017) [25]. He explained that this indicate physical education has an emerged multi-dimensional discipline. The main reason why this paper focus on evaluation of instrumentation based on a survey conducted in 12 sample universities of the department of sport science identified with the absence of basic measuring

instrument such as caliper. From a view point of sport profession one can understand how much student learning was extremely affected in the absence of using scientific instruments particularly in sport training at college and university level.

Advantage of Instrumentation for Physical education and sport science evaluation

Generally, evaluation of using instrumentation was inseparable from sport activity whether the activity was mental dominant like Chess game or physical like swimming. physical education and Sport Science highly center on evaluation for data collection and interpretation. According to MC Clain. J.J (2009) [14]. physical activity measuring instrument have been developed for the objective of investigation, intervention and evaluation purpose. It also used to follow the progress of the student fitness status, for recording, feedback, controlling and improvement, to establish bench mark in age and sex, measuring skill development among the student and for motivation are some of the reason to mention. To pursue students' progress like weight controlling or motor skill and fitness development it was essential to use scientific instrumentation to appraise their physical body and different components of health and sport related fitness. Terry Overton, (2008) [28]. describe that evaluation was built on assessment to justify whether the individual meet pre-determined criteria and the set procedure to decide qualification. The customary experience of evaluation was more of subjective based evaluation for performance and written exam for knowledge. In the existing advancement of sport such approach was not sufficient to give full evaluation result of students in physical education and sport science particularly for a professional trainer at college or university level. To make a comprehensive evaluation, scientific measuring instrument to be applied for the reason that the more the evaluation scheme be wide the better the evaluation standard or value. In this connection Robert Kizlik, (2019) [24]. show in the phrase that "Anything not understood in more than one way is not understood at all". Harbour, (2009) [9]. summarize his opinion by quoting "you can't understand, manage, or improve what you can't measure." According to the (National council on teacher quality) NCTQ, (2011), evaluation was a part of objective evidence of student learning support for the education system to improve teacher's effectiveness, student positive behavior and the development of curriculum. Wong (2019) [32]. explain that Whether the class produces positive effects on students' health, behavior, and academic performance depends upon the kind of program that was taught. From lower level to the advanced level of student who involved in major sport training it was necessary to make them aware and practice scientific measurement. Training first become meaningful when physical performance and further physiological assessments well analyzed and interpreted scientifically to take action or adjustment for future program. Some of scientific measuring instruments very common like a ruler ranging to more advanced level such as CT scan presented as example in the following table. The advanced type require specialization or need particular training for its implementation which mostly used, in sport research center and exercise physiology lab at college or university level. The important thing was to be starved for the need of necessary instrumentation to apply in test, assessment and evaluation in teaching, coaching and research. This list of instruments was the writer presentation used as an example that needed in physical education and sport at different level. This and related instruments were very essential particularly at college and university to go with the advancement of sport in the world.

Table 1: Instrumentation that can be used in physical education and sport science

No	Instrument	Purpose	No	Instrument	Purpose
1	Ruler	e.g. /sit and reach test/	14	Cycle ergometer	Endurance
2	Weight scale	Body mass or weight	15	Heart rate monitor	Heart rare in real time
3	Tape meter	Body Girth	16	Spirometer	volume of air inspired/expired by the lung
4	Stadiometer	Human height	17	Oximeter	Monitoring persons oxygen saturation
5	Watch	Time	18	Blood chemistry	Reference range of blood flood
6	Caliper	Thickness /width	19	ECG Electrocardiography	a recording the electrical activity of the heart
7	Dynamometer	Force /muscle strength	20	Electromyography (EMG	recording the electrical activity by skeletal muscles
8	Gonio meter	Range of motion	21	EEG Electroencephalography	Monitoring electrical activity of the brain.
9	Inclinometer	Angle of slope	22	CT scan computed tomography scan	Produce images of specific areas of a scanned object, to see inside the object without cutting.
10	Thermometer	Temperature	23	MRI Magnetic resonance imaging	form pictures of the anatomy and the physiological processes of the body
11	Pedometer	Count steps during walking	24	Electrodermal activity (EDA)	The property of the human body that causes continuous variation in the electrical characteristics of the skin.
12	Sphygmomanometer	Blood pressure	25	Cycle ergometer	Endurance
13	Treadmill	Walk or run speed	26	Sport technology	Multi-purpose

***Source*:** Based on survey research on scientific measuring instrument, from teaching material and literature review (2019).

The need of instrument for the evaluation of physical education and Sport Science

Measuring instrument simply used for *weight management to control related hazards*. Paula S. Turocy (2011) [21]. explain that weight management practice in sport should promote the safety and health of athletic performance. Using instrumentation also help for talent identification. Regarding this, O'Hara J, Chapman C, *et al*, (2016) [17]. show that *talent identification* involves Standard anthropometry, power, speed and estimate of Vo2 max for example as study conducted on each junior rugby league players. Furthermore, instrumentation assist players *placement* at advanced level. Evaluation of instrumentation also help to measure *training load* by analyzing the internal and external load variables. Gabbett TJ, (2016) [6]. illustrated that sport scientist also measure two type of training load. The first is external training load or physical performance such as (distance covered, weight lifted, sprint run etc.) and internal training load or physiological respond like (heart rate etc.). Using instrumentation also indicates *the impact of fatigue*

on performance. Smith, (2016) [26]. pointed that mental fatigue has constantly shown to damage physical performance during a self-paced and constant load test of endurance that require continuous exercise. Evaluation of using instrumentation support for controlling of *emotional arousal*. Sherri L. Jackson, (2006) [10]. pointed that, psychologist used measuring instrument such as the galvanic skin response (GSR) to measure emotional arousal, electromyography (EMG) recordings to measure muscle Contractions and electroencephalogram (EEG) recordings to measure electrical activity in the brain. Moreover, in addition to scientific instrumentation, in today's hi-tech involvement in sport evaluation may even further include the use of technology. Wang, (2010) [30]. suggest that New technology in education was playing significant role in classes. One of the most inexpensive and suitable tools was a simple video recorder. With this, students or athlete can see the mistakes they're making in their practical performance and this also used for evaluation method for the teacher. Studies demonstrate that students find easy video recorder more effective than having someone try to explain what they are doing wrong as a feedback. This help them trying to correct by the analysis of bio mechanical movement or simulation. On another approach of Evaluation, Scientific instrumentation also support to collect the participant way of performance indirectly through technology. Grimes, (2011) [7]. clarify that technologies can be used in a Physical Education situation include video projectors display to student's appropriate form or how to play certain games. GPS systems can be used to get students dynamic in and outdoor setting. This method assists teachers to show students in a good way to stay fit during in and out of the classroom setting. Grimes added that Computer also become a tool used in sport science for evaluation process based on information obtained from the analysis of the computer system. According to Arnold Baca, (2006) [1]. computer science has become an important partner for sport science primarily linked with

"*The fact that the use of data and media, the design of models, the analysis of systems etc. increasingly requires the support of suitable tools and concepts which were developed and available in computer science*"

In supporting this Link, (2009) [13]. explain that Computer science in sport has its goal, combine the theoretical and practical aspects. It applies methods of the areas of informatics and sport science. The main emphasis was the application and use of computer-based mathematical techniques in sport science and support for the advancement of sports and evaluation. In my view even in the upcoming in this advance digital era Microsoft chip will profoundly practice in sport for evaluating human performance. Such high level of Technological support will provide immense data in physical, physiological and bio mechanical movement etc. during sport training or sport competition in the near future.

Challenges that affect the implementation of evaluation using scientific instrument

One of the basic encounters to implement the application of scientific instrument for evaluation in physical education and sport science is lack of having well prepared curriculum that response the current demand of the student learning. In this connection Christen, (2010) study conducted in Zimbabwe indicated that element affecting physical education were poorly design of syllabi, negative effect of examination, teacher incompetency, inadequate resource, negative attitude of teachers and the head towards the subject was problem of Physical education. It was obvious that poor syllabi lead to missing the necessary part of the desired objective of student learning. Consequently, the evaluation will potentially affect the student to reach to the expected outcome. Beside this, it was also affected by lack of quality of teachers' skill training and commitment in the implementation of instructional process. Limitation of resource and lack of support by management bodies will also damage not only the quality of student learning but also it affects teacher's motivation to act in their full potentials. Accordingly, the emphasis of the limitation of the resource in this case, refer to measuring instrument, which extremely maximize the problem gap on implementation of the subject and its evaluation. The other major problem is the problem of fund to purchase the needed material. In this condition the problem was not only financial deficit rather the problem of decision making by the decision makers having the financial potential. Market cost was another related problem. In this respect Baranowski and Simons Morton (1991) [3] indicate that for example, indirect calorimeter may be needed for fieldwork but due to cost it was inconvenient to practice it. In general, it was a common challenge that teacher facing by limitation of fund to purchase the required instrument for teaching or research despite having the possibility to do by the school. Another part of evaluation problem was application of instrumentation related to limitation of time due to inadequate resource for example student size etc. which require extra time to evaluate each participant for the actual assessment. William A. Sands (2008) [31] indicate that coach do not give time for measuring, they only measure for research purpose for group data rather than specific measurement. Measurement should be individual and it was easy to make correct analysis for decision making but difficult to manage in time for large class size students. The other very significant challenges in implementation of measurement in evaluation was teacher's commitment. It was observed that despite the availability of measuring instruments the teacher didn't use the instrument or make distance from application of it in practice due to many reasons but one of the key reasons was teacher lack of commitment. According to Lean cross well (2019) [11], Teachers willingness to engage in cooperative, reflective and critical practice was a crucial issue which have a substantial influence on current education. So, the commitment of teacher was the most critical factor in implementation of the available resource during evaluation that need to be considered by the school, college and university.

Some of factor that affect measurement result in evaluation

Evaluation or measurement was not the end objective. The finial product of evaluation was a result which determine justification on measured thing. Result should be the reflection of the true measurement in all standards. Because it was the determining factor for valid decision making for the thing being measured accurately satisfying validity and reliability of measurement up to the accepted level of high standard. Richard Hogan (2013) [23]. pointed that Measurement result affected by the following 5 common influences. 1/selection of instrument affect measurement result. Appropriate instrument should be used to obtain correct data. For example, it was inappropriate to use a ruler

to measure the thickness of skin rather than fat caliper. Thus, the instrument should produce Repeatability, reproducibility and stability to obtain correct data, 2/ operator was another factor who perform the evaluation that affect measurement result. It required his education or particular certification. For example, Anthropometrical measurement needs to know anatomical land scape of the body, the correct measurable part of body location, the position of the measured person, the side of the body to be measured necessitate to accurately measure using the appropriate instrument. Thus, skillful training and expertise ability of techniques of measurement are very important matter. 3/environment also affect measurement result. For example, Body weight and height have diurnal effect. Kelvin (2004) revealed that body mass shows diurnal variation about 1 kg in children and 2 kg in adults. Similarly temperature, humidity, pressure, stress, lab measurement compared to field measurement etc. can affect measurement result 4/ methods of application for similar measurement affect measurement result for example body fat measurement have several method such as caliper, body circumference measurement, hydrostatic, Bioelectrical impedances, dual-Energy x-ray absorptiometry (DEXA) and others 5/calibration service provider on the calibration of the instrument or calibration has an influence on measurement results. So, these all and other related issues need to be considered during evaluation result.

Focus on Scientific measurement implementation for evaluation

The following very important point need to be considered for the implementation of evaluation using scientific instrument.1/To make available the limited material, according to pate (1997) [19]. it was impossible to satisfactorily achieve student learning with inadequate instrument and facilities. So, availability of measuring instrument for evaluation is essential. 2/To select relevant instrument to achieve the objective in (teaching, coaching or research) practice. Peter A, (2014) [20] described that student who show more involvement in motor appropriate activity where there was unlimited amount of equipment. 3 / To have the required knowledge and skill how to use the instrumentation. In this respect he pointed that even student significantly show participation where there was available instrument. 4/commitment of teacher to use the available instrumentation. Stomech A and Bogler R (2002) [27]. specify that teacher commitment lead to promote teaching profession, work performance, school and student achievement. Hence, committed teacher were more satisfying in teaching and always strive for accomplishment of good instruction. 5/To use the available material. It was known that Access to adequate physical equipment and facilitates was positively associated with student activity level. 6/ To apply scientific guideline for measurement instrument in sport for evaluation. According to AW Onyango, (2004) standardization and faithfulness to measuring procedures during data collection are vital. In general, applying appropriate prescriptions and following scientific procedures and protocols essential related to the type of evaluation carried out in physical education and Sport Science. Depending on the level of school and specialization application of scientific instrumentation was very significant for testing, assessing, measuring and evaluation for athletes' health, safety and better performance. Understanding and familiar with equipment and using standard guidance was very central with repeated practice for evaluation. Thus, teachers, coaches and exercise professional should develop the skill necessary to accurately test and measure the specific variable and eventually become successful and proficient in using measuring instrumentation in evaluation. in addition, Test and measurement should be Standardized and valid. 7/To take care of the material and maintain it as to provide consistent standard measurement, Bucher and Korte (2002) stress that facilities and instrumentation should be maintained in serviceable condition for reliable and require to use correct and appropriate measuring instruments.

Conclusion

Evaluation was an important tool to judge and value the quality of the learning outcome in education. As well known, there were many mechanisms of evaluation in physical education and sport science. The common one was written exam and subjective judgment of physical performance. However, it was observed that there was limitation of using scientific measuring instrument as an evaluation method in some sample universities that are assessed in a survey research.it was obvious that with the limitation of measuring resource it was difficult to manage the student learning achievement with today's sport advancement and evaluation. So, such evaluation gap that exist cover not only at school level but also at college and university where sport learning and training conducted as a specialization. Some of the need of scientific measuring instrument in physical education and sport science were weight management, talent identification, for health screening of the participant, players placement, for training load measurement, indicate impact of fatigue, for controlling emotional arousal are some to mention and which generally cover physical, physiological, performance and psychological condition. Evaluation with instrumentation helped for intervention, investigation of fitness, for controlling improvement, to design a bench mark, for skill development, recording, feedback and motivation are some of the reason. The common challenge of scientific instrument in physical education and sport science evaluation was, not having well prepared curriculum, inadequate resource, fund limitation, time limitation, quality of teacher skill training and teacher commitment. There was also some factor that affect measuring instrument in evaluation of physical education and sport science like selection of equipment, operator, environment, the relevant method and calibration. The Point to be considered during implementation of scientific measurement in the evaluation of physical education and sport science are to make available the limited material, select the relevant instrument, have skill to use the instrument, commitment of teacher, to use the instrument, apply the scientific guideline (protocol) and maintain the material. This paper will encourage teachers and sport scientist in the field to make further research in this particular issue which was not yet well researched in measuring instrument as an evaluation part in physical education and sport science.

Recommendation

- Scientific measuring instrument in evaluation is very essential to the current demand for the development of

sport at school, college and university level.

- Let the curriculum be improved which will be suitable for practical in measurement and evaluation for teaching, coaching and research work.
- Teachers willingness and commitment contribute the most critical factor in the implementation of the available measuring instrument during evaluation.
- Fund and its allocation for instrument significantly will address in to student learning dynamic.
- To Use standard measurement protocol and guidelines in using measuring instrument in evaluation is extremely necessary.
- Let us include some % age of instrumental evaluation beside subjective and written exam.
- Student should know their initial fitness level for their own progress throughout the year.
- Let student do some project and peer measuring practice during teaching learning process and research with the use of instrumentation.
- Let the school give more attention to sports in school.

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