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Effectiveness of Determinants of Science Education at Secondary Level

^a Ehsan Qadir Malik, ^b Shamim Haider Tirmazi, ^c Mubashrah Jamil

^a PHD Scholar, Department of Education, Bahauddin Zakariya University, Multan, Pakistan

^b Professor, Department of Education, Bahauddin Zakariya University, Multan, Pakistan

^c Assistant Professor, Department of Education, Bahauddin Zakariya University, Multan, Pakistan

Email: mubashrahjamil@bzu.edu.pk

ARTICLE DETAILS	ABSTRACT
History: Accepted 25 April 2021 Available Online June 2021	<i>The study was focused on identifying the determinants of science education and to examine the effectiveness of determinants of science education at secondary level. Population for the study consisted of science teachers of public and private sectors at secondary level of Punjab province. Sample was selected randomly which comprised 370 science teachers. In this quantitative study, questionnaire was preferred for teachers as a tool; a checklist was formulated for determinants. Proposed determinants were identified by a checklist. Through pilot study, the questionnaire was validated. The major conclusions showed that science objectives are understandable, logically structured, and their quality reflect enrichment of science education material. Textbook material is effective, logical in arrangement and according to the students pace. Teaching in science education demands competency of teachers and students' attitude can be made precise which demands motivation. Effectiveness of science education is enriched by different assessment techniques which provide the criteria to fulfill the behavioral objectives.</i>
Keywords: Determinants, Effectiveness, Teacher's Verbal Feedback, Science Education, Secondary Level, Quality	
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Corresponding author's email address: mubashrahjamil@bzu.edu.pk

1. Introduction

In the present era, knowledge based on scientific facts and laws have become an essential need of the society. Science has helped the man to acquire supremacy over nature. It has greatly affected the people and the world around them. Science education is based on logical scientific reasoning, it provokes thinking and it reflects not only the scientific contents but also more effective methods of teaching those contents. Many quires especially at secondary level have now made an integral part of science education curriculum. At secondary level students are encouraged to find problems themselves, propose their own methods of investigation, make their own observation and draw their own conclusions. The effectiveness of science education at secondary level is universally recognized (Bhaskara & Vijava, 1995). Determinants are those potential ingredients which carry

science objectives with the help of communication to the domains of behavior. Effective communication is a two way process including interaction and feedback.

One of the determinants which is to identify feedback how useful and how effective they are in constructing knowledge and scaffolding thinking. A dominant responsibility of teachers within any learning situation is the provision of feedback; moreover feedback is deep-rooted in the educational process. Feedback facility highlights the demands on teachers if they are to teach effectively. Research has proved that the right kind of feedback is crucial for effective teaching and learning (McMillan, 2007; Hattie & Timperley, 2007) which is a demand of the day.

In this lieu, feedback is very critical in developing knowledge and skill attainment (Shute, 2008). But still some conclusions proposed the application of feedback with serious concerns. Feedback can be referred as a message delivered by a teacher concerning understanding or performance of a student. So, feedback is a “consequence” of performance, and “debatably the most important part of the assessment process” (Price et al, 2010; p. 5). It is a crucial driving power behind providing educational assessment. In other words, it activates learning more considerably. Student’s individualities like self-directed and self-reliant learners are the products of Feedback. In pedagogical application the exercise of feedback is critical as it gives affective provision to the learner and support motivation for learning sustainability (Ellis, 2009). Quality feedback focuses on students’ output and how to improve it, extending teacher-student interaction; students’ communicative and argumentative capabilities are certainly enhanced. Their oral and aural abilities are thus refined, their previous knowledge is put to use, and their learning is scaffold and enhanced (Gibbons, 2006).

The teaching of science needs to be viewed as trained, educated beings within a profession. There are numerous techniques to appraise pupil achievement in the science education (Preston and Harman, 1981). A teacher must be encouraged to improve science teaching usefulness and utility by applying an optimistic attitude by understanding students’ learning problems and difficulties; acknowledging individual differences; and also being capable to organize and teach in interesting, flexible and relevant way. This could also be done though different teaching methods; understanding students’ learning abilities and skills and then to plan and structure the content and the use of practical exploratory science in the classroom. Darling- Hammond (2000) expressed that only those teachers can effectively and efficiently teach and improve student achievement if they themselves have strong academic skills.

The effectiveness of determinants can be studied. Effectiveness is concerned with output and organization effective to the extent that it produces output i.e. relevant to needs and demand of its clients (Grevillee, 1986). Effectiveness is a measure of the extent to which an activity achieves its objectives (Zaki, 1988). The effectiveness may be measured in terms of quality, usefulness, utility, novelty and creativity. Effectiveness can also be observed with minimum input related to maximum output. In Pakistan, at secondary level, especially in science education, students with scientific background face a lot of problems. The present research would be an effort to study the effectiveness of determinants of science education at secondary level. It is true that if effectiveness of determinants is not well understood by teachers and students, it is obvious that performance of students will suffer. To understand the nature of problems faced by students at secondary level, the effectiveness of determinants is of more importance. This study would serve as a useful guide to look into the effectiveness of determinants of science education at secondary level.

Determinants of science education at secondary level are science objectives, curriculum, contents, interest, latest happening around the world, appropriate pre-service training, in-service training, furnished building, well equipped laboratories, adequate library facilities, environmental resources, practical work, practical examination, scientific literacy, learning opportunities, effective communication, assessment score, achievement, student support services, internet and application of science education. Keeping in view the importance and determinants of science education at secondary level, it was necessary to conduct a research whether these determinants were as effective as narrated in previous and new studies in Pakistan scenario.

Objectives of the study were:

- a) Identify the determinants of science education at secondary level and;
- b) Examine the effectiveness of determinants of science education at secondary level.

2. Review of Related Literature

In this age of science, teachers are seen as a significant component in achieving scientific literacy. The teaching and professional development work together to address the insight of achieving content knowledge, knowledge of the learning process, knowledge of effective teaching methods in classroom activities, knowledge of student's developmental levels, knowledge of the educational vision, mission, aims, goals and objectives, and knowledge of the curriculum inside the school or outside the school. A science teacher promote positive learning environment which enable students to be successful in science learning experiences and cultivate positive thoughts towards future science learning both in classroom and throughout life. Science is a systematic and logical way to discover how things with universe work. Hussain (2005) viewed science aimed for measuring results through process of analysis which is based on scientific facts. McComas (1998) viewed science is an attempt to explain natural phenomenon. Collette & Chiappetta (1984) illustrated science is a basic enterprise that seeks knowledge and understanding which is aligned with observation and theory.

In classroom activities Farmery (2002) pointed out that science teacher may encourage students to think critically for problem solving, observing, depiction of world, discovering in quest of truth, studying nature, facts into theories, arranging knowledge, using convergent and divergent reasoning and studying the universe. In other words, science is a way of thinking, doing and communicating of science area studied at secondary level. Rao (2003) described a variety of principals and procedures. According to him the activities are called process of science and the finding and discoveries comes the product of science. There are three aspects of science knowledge; understand, explain and apply. Science is seen as part and parcel of culture and powerful way of thinking.

The science teachings importance about the nature and the relationship of science, technology and society cannot be undermined. Fonts & Myers (1992) evaluated that teachers should apply to different appropriate styles of teaching methodologies, strategies and techniques taking into account the individual characteristics of students. Osborne, Simon and Collins (2003) determined that it is teacher quality which is the biggest determinant of student engagement with science. Hume and Berry (2011) explored student- teachers can develop scientific inquiry process through engaging in constructing their own content representation for new topics.

Feinstein (2006) argued that science education should focus on the useful aspects of scientific

literacy. Today in science education much attention directed to science processes and on the knowledge skills. Science education is enriched much more than previously in contents and processes. Hussain (2005) concluded that science education should provide students a balanced review of principles of scientific knowledge and opportunities to effectively develop an appreciation of scientific methods.

The innovative trend in science education has valued in society and students learning enhanced. Science education contributes to improve fairness and encourage learners to become skillful by setting their own personal goals about science and technology. Science students are more appropriate to understand the natural world if they are given opportunities to work directly with the natural phenomenon and enhance their learning. Osborne et al (2003) opined that Curriculum, pedagogy and assessment interrelate with each other. Student learning can be enhanced by change in the curriculum, teacher change his pedagogy to meets the demands of curriculum and transforming the teaching of science. These cannot take place in isolation. It is possible with teacher commitment with intellectual skills and scientific attitude of learners.

The process of science is increasing its scope in future and performing in different methods that scientist use to solve problems. It is evident that critical and creative thinking can be important for the students at secondary level in solving problems. Scharmann (1989) points out that science processes skills promote subject matter, understanding and science content knowledge because they inter mingle each other. Science process skills are the tools that students use to investigate the world around them. Anderson (2002) stated that science process skills form an important part of scientific inquiry and promote scientific literacy among students. Students learn about the nature and process of science.

Quality science education is the main concern of all nations in the world. Standards describe quality, what standards planners need to know in order to enhance a scientific literate society. McComas (1998) viewed that scientific knowledge relies on experimental evidence, rational arguments, skepticism and durable has a tentative character. Some indicators of quality i.e. complete view of science subject, subject matter knowledge, pedagogical skills and awareness about students in the definition of highly qualified teachers (Rice, 2003).

Government of Pakistan is committed to improve quality of education in government policy documents (national educational policy 1998-2010). A specific priority is to build assessment capacity at the school, provincial and federal levels for better measure learning outcomes and improve the quality and effectiveness of program intervention. Education system requires assessment to suggest measures to improve the whole system. The quality of science education has remained top priority in all sectors i.e., public and private. Student achievement in science and assessment are indicators of quality. For measuring the performance of science students learning outcomes at secondary level is the priority within the students learning level. For this, the program at secondary level is to improve the quality and effectiveness.

Pakistan is lacking behind in the area of science assessment for quality learning. It is the power to understand the individual learning difficulties, Govt. of Punjab, (2008). Student level of achievement and science utility and usefulness is necessary for the improvement and performance of the system. Fleischmann (2007) argued that educational experience in form of standardization can improve top down standards. There is an urgent need and desire to satisfy the science student

necessities through quality. Mahmood (1984) claimed that important purpose is addressing the students to make them science mind, induced them to take up science as a subject for studies. It is only possible with quality education. The purpose of present study was to explore the effectiveness of determinants of science education at secondary level.

3. Methodology

3.1 Research Design

The study was descriptive in nature and survey design was used to collect the data. By applying quantitative approach the researcher expected to maximize investigation of determinants of science education at secondary level.

3.2 Population, sample and sampling

Population for the study consisted of science teachers of public and private sectors at secondary level, who were teaching during the session and having five years of experience and expertise in their respective fields of science. Sample was selected by simple random technique. In this way ten (10) teachers from each district of the Punjab Province were selected in such a way that sample appeared to be representative the population by gender, socio-economic status and science teaching experience. Sample comprised of 370 science teachers.

3.3 Research Instrument

After receiving the related material, a checklist was formulated relating determinants. Proposed determinants were identified by a checklist and these determinants were further related to re-established objectives. Questionnaire therefore, based on likert scale was developed on 5-points, keeping in view the determinants i.e. Objectives, Textbooks materials, Teaching in science, Science teacher Personality, Assessment were important aspects. In first step 20 percent of the sample teachers were selected randomly from targeted population for pilot study and in this way questionnaire got validated. The Questionnaire along with covering letters for teachers was sent under postal coverage. The 281 out of 370 teachers (76percent) were received back and data was analyzed accordingly.

4. Results and discussion

Person measurement (Teachers Score on Attitude Scale) was on Five point Likert scale comprising fifty six statements. The scale was 281 teachers and their score was recorded in tabular form.

As the maximum and minimum score on the scale could be 168 points (56 x 3). It was inferred that majority of teachers showed their acceptance for the effect. The maximum score on attitude scale max score was 264 and minimum score was 148. At secondary level, especially in science education students with scientific background face a lot of problems. To understand the nature of problems faced by students at secondary level, determinants are more important. Adesoji (2008) constructed eight variable models for providing a causal explanation of achievement of secondary school students in chemistry. Olatoye (2011) developed a causal model of school factors as determinants of science achievement in secondary school and Odunko (2002) discussed home and school factors as determinants of literacy of skill development among pre- primary school children.

The proposed determinants of science education at secondary level by the researcher are the science objectives, quality of text book material, contents, interest, science teaching, well-equipped

laboratories, adequate library facilities, environmental resources, practical work, assessment, student attitude, effective communication of science education. Teachers 80 percent favored various form of knowledge i.e. Content knowledge and pedagogical skills needed by effective science teacher in science teaching. They also noted that teachers need to have fruitful training regarding science knowledge and skills in issues related to secondary level science subjects. Teachers further commented that science is part and parcel of teaching quality , it happens only as they commented, equipped with library which comprised on latest edition of reputed books and ease in the reach of students.

A qualified enriched science teacher as discussed Attila (2007) is who know subject contents well and helps in promoting scientific literacy and foster an understanding and appreciation of science among science students at secondary level. Furthermore, an important area of teacher's pedagogical skills is ability to organize and teach students at secondary level in interesting and logical way. The teachers psychomotor skills is the ability of teachers to explain clear scientific information during practical work, their issues regarding concepts ,handling difficulties, students relevant questions with positive discussion. A teacher positive approach as discussed by majority teachers is good communication which helps students in understanding scientific concepts and phenomenon effectively.

To understand the nature of problems faced by students at secondary level, the effectiveness of determinants is of most important. Effectiveness may be measured in terms of quality, usefulness, utility, novelty and creativity. An effective science teacher promote and encourage science student with the role of discussion in helping students to learn science e.g. Team teaching, peer teaching, cooperative teaching. These novelties in teaching along with utility and usefulness may promote student learning in terms of information and incorporate new experiences. In this lieu Joyce et al (2000a) favored that cooperative learning can foster the development of deep understanding.

Preston (1981) indicates numerous techniques to appraise pupil achievement in science education. Grevillee (1986) viewed that effectiveness is concerned with output and organization effective to the extent that it produces output. The effectiveness of determinants enables the students about problem solving and decision making skills and discovers the relationship of determinants of science education with domains of behavior. Osokoya (1998) urged the researchers to study some determinants of secondary school students. He gave little attention toward effectiveness of determinants. Zaki (1998) viewed that effectiveness is a measure of the extent to which an activity achieves its objectives. Some teachers in Punjab opined that most of teachers do not enter the classroom with objectives but majority of science teachers viewed that teachers remained connected with teachers professional standards, curriculum which based on objectives and assessment to achieve an aligned system with supporting subject based in service training.

In Punjab (Pakistan), there are different levels of science education. At secondary level students with scientific background face a lot of problems. Students seem to be aware of their personal qualities. 85 percent teachers stated that Students behavior associate with effective teaching which makes student respectful especially at secondary level.15 percent teachers explained that although secondary level student age is emotional but their positive attitude, respect develops interest and enthusiasm in them which motivates them toward learning with quality, Along with this, teachers understood that teachers attitude also, effected student learning was the core of science education process.

It is true that if effectiveness of determinants is not well understood by teachers and students; it is obvious that performance of students will suffer. In researcher own view this study will serve as a useful guide to look into effectiveness of determinants of science education at secondary level and also enables the learner to acquire problem solving and decision making skills about the effectiveness of determinants.

5. Conclusion

Through the results of this study it was depicted that the effectiveness of determinants to define science education by features and can struggle for the high standards in science education. Odunko (2002) discussed home and school factors as determinants of literacy of skill development among pre- primary school children. The proposed determinants of science education at secondary level by the researcher are the science objectives, quality of text book material, contents, interest, science teaching, feedback, well-equipped laboratories, adequate library facilities, s, practical work, assessment, student attitude, effective communication of science education. Previous researches like Olatoye (2011) developed a causal model of school factors as determinants of science achievement in secondary school.

The research under study shows that science objectives are understandable, logically structured and appropriate give clear direction and their quality reflect enrichment of science education material. Further, Textbook material is effective, logical in arrangement, according to the students pace, students are mentally satisfied and usage of textbook material enables students to apply the knowledge to real life. Teaching in science education is scientific in nature which demand competency of teachers. This related to Darling- Hammond (2000) findings that teacher quality components are subject matter and pedagogical skills which are very strong academic skills. While students attitude can be made precise and exact which demands motivation. Moreover teaching in science education develops positive thinking. Science teaching enables students to achieve the academic purpose effectively. Science teaching helps teacher to evaluate progress toward achieving educational objectives.

Teacher professional qualifications have a positive effect on the student behavior while personality of science teacher motivates the students and science teacher can create interest among student in their subjects. Science teaching assessment process is continuous and it is in practice after completion of course. Assessment is done keeping in view suitable ratio between theory and practical and assessment based activities provide feedback to students. Effectiveness of science education is enriched by different assessment techniques, within assessment teacher directs students to use other sources of information. Assessment provides the criteria to fulfill behavioral objectives and assessment of students provide feedback to teachers of science subjects. Results of this study do confirm previous finding, Osborne et al (2003) that Curriculum, pedagogy and assessment interrelate with each other. Student learning can be enhanced by change in the curriculum, teacher change his pedagogy to meets the demands of curriculum and transforming the teaching of science.

6. Recommendations

Curriculum developers and writers may incorporate the intended learning outcomes for teachers as well as students separately in science subjects at secondary level and may also include cognitive activities that may be helpful for students to apply the scientific knowledge and they relate them to real life situation.

Science teachers often do not take their class with complete preparation. Teachers who want to become successful in their professional lives remain in struggle. Therefore, it is important to plan for teachers' professional development program; curriculum and assessment in an alignment for assist them.

Continuous professional development is deemed important for maintaining science teachers' professional qualities. Higher authorities should ensure that all teachers must be given an opportunity to improve their quality of teaching through these types of trainings. This would be most effective for in-service teachers to learn effective teaching techniques. This would ultimately affect students' learning interest and supportive in attaining high quality teaching-learning objectives.

In order to assess the effectiveness of science education, a criteria should be developed for the measurement of behavioral outcomes and to integrate determinants for effective science teaching at Secondary level.

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