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RESEARCH PAPER

Developing Science Concepts of Students with Visual Impairment through ADDIE Instructional Design Model versus Conventional Teaching

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ABSTRACT

The objectives of the study was to develop science concepts of students with visual impairment (SWVI) through ADDIE instructional design model versus conventional teaching. Experimental study under quantitative approach followed a quasi-experimental research design was adopted to collect data from 20 students. 10 students out of 20 were randomly selected for treatment/experimental group while 10 students were randomly selected as control group from (Govt. Sunrise Institute for the Blind, Ravi Road, Lahore). The multi-stage random sampling technique was followed to get the sample of 20 students from 37 students at elementary level. In the experimental group, about 10 students received intervention using ADDIE instructional design model, while the control group received conventional teaching. Pre-tests were administered to both groups and after a twelve-week intervention, post-tests were conducted. Independent t-tests and paired sample t-tests were used to analyse the results.The findings indicatethat learning enhance in abstract concepts of science to SWVI at grade 6th by using instructional package as compare to conventional teaching. It was recommended that to teach logical reasoning and analyzing skills among students with visual impairment, teachers need to tailor instructional strategies to meet the unique needs of visually impaired students in science education.

Keywords: ADDIE Instructional Design, Conventional Teaching, Science Education, Students with Visual Impairment

Introduction

Traditionally, blind and visually impaired pupils have not been able to quickly access sophisticated visual information in a way that is suitable for widespread usage. Because of this lack of knowledge, blind people become less interested in scientific fields. As a result, there aren't many blind scientists working today who can set guidelines for teaching blind people science and act as mentors and role models for blind students who aspire to work in the sciences (Schleppenbach, 1996).

According to Gast et al. (1992) and Wright & Wright (1998), these children usually require a range of opportunities to investigate and study real things/models by touch or by putting them through residual visual observation. Due to their visual impairment, some modifications and cooperation should be made for them to have safe and complete access to the science curriculum in both the lab and the science classroom (Mastropieri & Scruggs, 1992; Maguvhe, 2003). It is observed that numerous guides and manuals are available that describe how to develop evidence-based practices and teach science to children who are visually impaired.But according to recent research on these manuals, most of the studies concentrate on different science-related topics like teaching science concepts, developing scientific process skills, conceptual understanding, and the usefulness of these curriculum materials and inclusion (Erwin et al., 2001; Fraser &Maguvhe, 2008; Hadary& Cohen, 1978;

Kızılaslan&Kızılaslan, 2018; Kumar et al., 2001; Rule, 2011; Wild & Trundle, 2010).Thus, the most important thing that special educators should remember and consider is to thoroughly reorganize and revise scientific education curricula while taking into account how to make it accessible to students with disabilities (Scruggs & Mastropieri, 1993; Tindal &Nolet, 1994). The Individuals with Disabilities Education Improvement Act (IDEA) also emphasizes this need, stating that science teachers must make the general curriculum as accessible as possible to all students (IDEA, 2004). Nonetheless, there are a number of problems with how visually challenged pupils are taught science. These problems stem from the fact that scientific education and instruction have not appropriately accommodated these pupils (Kumar et al., 2001).

Although they get information through other sensory modalities (auditory, tactile, and olfactory), kids with visual impairments have the same range of cognitive abilities as normal students; nonetheless, the information they receive may be limited and unclear (Calderon & Naidu, 1999; Hartmann, 2013). As a result, while deciding how to make materials accessible, the special needs of these kids are frequently overlooked. For example, educational resources designed for pupils with visual impairments could lead to the neglect of measuring tools, reading charts and written materials, and laboratory supplies. It is necessary to distinguish between functional skills and compensating abilities in order to provide students with visual impairments with access to the curriculum. There are similarities among inquiry-based science teaching and learning strategies for kids with visual impairments. For a student with a visual impairment, using their senses to explore tangible objects to deepen their comprehension, questioning findings, and testing those discoveries become second nature. These popular teaching strategies will improve students' comprehension, pique their curiosity, and open up new career options for them when used in science classes. An inquiry-based approach to education emphasizes hands-on activities and role-playing scientific experiments where students engage directly with the phenomena they are studying.In an inquiry-based classroom, students are given critical opportunities to become better problem solvers and thinkers about the world around them. These opportunities include integrating visually impaired individuals into general education classes. Students with visual impairments have historically not had access to science and mathematics. High-tech, complex subjects containing a lot of visual information include chemistry, physics, engineering, biology, and mathematics.

Science is a difficult topic for visually impaired people to learn and teach, as well as to take as a student, unless the appropriate adaptations, accommodations, and assistive technology are employed. A scientific student who is visually blind can learn and complete tasks just like other science students with the correct techniques and assistive technology. It can be quite costly to teach pupils with assistive technology, accommodations, modifications, and specialized training. There are few and uneven teacher training programs for teaching science to blind and visually impaired students, with respect to the proficiency level in terms of assistive technology and techniques (Ambrose, Zaken& Bozeman, 2010; Wild & Allen, 2009). Even though there are many problems with scientific education, there are a number of changes that may be made in this area to better serve visually impaired children now and in the future (Mwakyeja (2013). It is unlikely that VI kids have learning disabilities; instead, it is more likely that they just require accommodations and additional time to catch up with their sighted peers. They can study anything and succeed just as much as their sighted classmates if given this chance. As members of the community, they are entitled to equal educational opportunities. Learning environments and curricular materials need to make certain concessions in order to give VI kids an equal chance at an education (Sahin, &Yorek, 2015).

Science education should be accessible to all learners, especially children with specific educational needs. Science learning needs to be prepared for all learners and for further education, employment, and independent living. A student with visual impairment is one of the kinds of SEN pupils who have restrictions in acquiring information via their eyesight sense. Science learning needs to be prepared not only for all learners but also for further education, employment, and independent living (Individuals with Disabilities Education Act). Many countries' governments have emphasized the importance of including students with special needs in regular classrooms. Inclusive schools must accommodate the diverse needs of students (Bavlı et al., 2020). The blind or visually impaired student will likely need specific adjustments to access the science programme safely and thoroughly. Students` specific visual demands should be considered while considering how to make resources accessible.

Literature Review

Scientific literacy, or the knowledge and comprehension of scientific concepts and procedures, empowers people to apply scientific principles and procedures to make decisions for themselves and to engage in meaningful debates about significant science and technology-related topics (Bybee et al., 2009). Thus, science literacy is less about memorization of information and more about applying science principles to explain what you observe (Dani, 2009).

Having scientific literacy is being able to recognize questions and interact with scientific concepts to find answers to enquiries motivated by interest about commonplace occurrences. It indicates that people are able to characterize, interpret, and forecast natural events using scientific information (Millar, 2006). Students who participate in the scientific inquiry process are able to recognize questions that can be addressed by scientific research, collect, analyze, and interpret data using the proper instruments and methods, create descriptions, explanations, predictions, and models based on evidence, verify their explanations against the state of science, and present their ideas to others (Buczynski& Hansen, 2010). The development of cognitive abilities through first-hand observation of scientific activity is the focus of science. Some fundamental science skills that can be developed through scientific activities include learning scientific language, making observations, taking measurements, gathering, analyzing, and interpreting data, drawing conclusions, building models, communicating, and conducting investigations (Wild et al. 2013). Engaging in practical science activities is linked to the advancement of numerous scientific concepts, abilities, and mindsets. By integrating "minds on" and "hands on" activities, science activities allow students to actively engage in the scientific process. Stated differently, pupils enhance their comprehension of scientific principles by associating scientific expertise with critical thinking and reasoning abilities (Breslyn& McGinnis, 2011).

An enlarged core curriculum is necessary so that students with disabilities can engage in practical science projects with their classmates. It has been suggested that scientific instruction be learner-centered, moving from the known to the unknown, utilizing interactive activities with materials from their surroundings, and realistic manipulatives (Wild & Trundle, 2010).

This strategy, according to some (Browder et al., 2010; Byrne, 2014; McGrail and Rieger, 2013; Thomas & Imrie, 2008; Andrews, 1998), will raise students' awareness of and appreciation for science.

According to scientific estimates, vision can explain as much as 90% of the academic, social, and functional skill-related knowledge that a seeing youngster acquires about the environment (MacCuspie, 1992). Because of this, teaching visually challenged children requires unique techniques (Koenig &Holbrook, 2000; Lowenfeld, 1974).

Hypotheses

The following were the hypothesis:

1. **Hypothesis**

Null Hypothesis (H0): The science score of SWVI of control group and experimental group studying at grade 6th do not differ.

Alternative Hypothesis (H1): The science scores of 6th grade SWVI of experimental and control groups will differ significantly.

2. **Hypothesis**

Null Hypothesis (H0): SWVI taught through instructional package will not achieve higher science scores compared to those using traditional methods.

Alternative Hypothesis (H1): SWVI taught through instructional package will achieve higher science scores compared to those using traditional methods.

Methodology

SWVI enrolled at elementary level in the Govt. Institute for the Blind, Ravi Road, Lahore was selected as the population of the study.

Exclusion criteria: Children with multiple disabilities and on medication was excluded from the study.

Sample

One School was selected based on the maximum enrollment of students with visually impaired. 20 students enrolled in grade 6thwere selected out of 37 students.

Research instruments

Research instrument pre-test and posttest were developed from Science Book of Punjab Text Book Board for grade 6th. It was mainly comprised of multiple choice, short questions (open ended) and long question (open ended) which contained different items from the following units:

The items format of both tests was multiple choice 30x2=60, short questions (open ended) 10x2=20 and long question (open ended) 4x5=20.Validation of instrument was done from 5 Science teachers (2 from regular schools and 3 from schools for blind) who were teaching Science (Elementary level) at schools in Lahore

Intervention

Based on research design (ADDIE), the scientific instructional package was developed in five stages: analysis, design, development, implementation, and evaluation of learning activities and resources. Science instructional packages are made up of a number of key components and pillars that are arranged consistently and harmonically, presented to students in an easy-to-understand manner by the teachers, and based on particular standards and goals that are tailored to the target group and various educational contexts. The most important components of the instructional packages are introduction of IPTS, objectives of instruction package, guidelines for teachers, adaptive resources SWVI and topic of units (Specific Objectives, Instructional activity, Instructional resources, Assessment criteria).

For the control group, however, no lesson planning was done during the study's intervention phase. The sixth-grade visually impaired children in the control group received science instruction according to the standard procedure currently in place. However, the students in the control group were taught the same material in order to characterize the process there as well as to ascertain how different it was from the experimental group. The researcher employed a frame and stylus, Perkin braille and braille books, lecturing, and open-ended class discussions as the sole teaching methods for the control group; no instructional material kit was used.

The intervention took place over a twelve-week period. In accordance with the school's schedule, the researcher spent forty to forty-five minutes a day, six days a week, teaching science to sixth-grade visually impaired pupils using an educational package. Following the conclusion of treatment, a post-test was administered.

Results and Discussion

Table 1
Descriptions of sample selection of SWVI

Total schools for visually impaired in Punjab= 15	
School selected as a sample= 1	
Student's Number in selected school= 20	
Control Group= 10	Experimental Group= 10

Table 2
Demographics characteristics of students with visual impairment

Variables	Details	Description
Gender	a. Male	All of the respondents (100.0%) were male.
Level of vision Loss	**a.** LowVision 30.0 **b.** blindness 70.0	Majority of the participants had (70.0%) were blind
Respondent's Age (In years)	a. 15 10.0 b. 16 30.0 c. 1740.0 d. 18 20.0	Majority of the respondents (40.0%) 17 years old.

Table 3
Pretest Science score of SWVI of experimental group

Sr.no	Students	M.C.Q.s (60)	SQ (20)	LQ(20)	Total (100)
1.	Case-1	10	05	08	23
2.	Case-2	10	11	08	29
3.	Case-3	16	10	09	35
4.	Case-4	20	12	13	45
5.	Case-5	08	05	08	21
6.	Case-6	10	10	05	25
7.	Case-7	08	04	08	20
8.	Case-8	14	10	10	34
9.	Case-9	18	10	10	38
10.	Case-10	10	05	10	25

The table pretest Science score of SWVI of experimental group indicates minimum scores obtained by SWVI 20 out of 100 marks and maximum scores obtained by SWVI 45 out of 100 marks.

Table 4
Pretest Science score of SWVI of control group

Sr.no	Students	M.C.Q.s (60)	SQ (20)	LQ(20)	Total (100)
1.	Case 1	10	10	05	25
2.	Case 2	16	09	10	35
3.	Case 3	10	08	11	29
4.	Case 4	08	10	05	23
5.	Case 5	18	10	10	38
6.	Case 6	20	13	12	45
7.	Case 7	08	08	04	20
8.	Case 8	10	10	14	34
9.	Case 9	08	08	05	21
10.	Case 10	10	10	05	25

The table pretest Science score of SWVI of control group indicates minimum scores obtained by SWVI 20 out of 100 marks and maximum scores obtained by SWVI 45 out of 100 marks.

Table 5
Independent Sample t-test Comparing Pretest Score of Control & Experimental Group in subject of science

Pretest Score	Groups	N	Mean	SD	t- value	df	P
	Control Group	10	77.40	1.95	0.11	18	0.91
	Experimental Group	10	77.50	2.06			

Independent sample t-test was performed to compare the pretest score of control & experimental group in subject of science. The results indicates that there is no significant difference (t:0.11; P: 0.91) between pretest score of control & experimental of students with visual impairment studying at grade 6th.

Table 6
Posttest science score of SWVI of experimental group

Sr.no	Students	M.C.Q.s (60)	Short questions (20)	Long questions (20)	Total Marks (100)
1.	Case 1	16	16	16	48
2.	Case 2	30	10	11	51
3.	Case 3	30	15	15	60
4.	Case 4	36	16	16	68
5.	Case 5	34	12	13	59
6.	Case 6	40	16	15	71
7.	Case 7	32	17	17	66
8.	Case 8	44	15	15	74
9.	Case 9	36	15	17	68
10.	Case 10	38	16	16	70

The table posttest Science score of SWVI of experimental group indicates minimum scores obtained by SWVI 48 out of 100 marks and maximum scores obtained by SWVI 74 out of 100 marks.

Table 7

Independent Sample t-test Comparing Posttest Score of Control & Experimental Group in subject of science

Posttest Score	Groups	N	Mean	SD	t- value	df	P
	Control Group	10	76.50	1.84	7.32	18	0.000
	Experimental Group	10	92.90	6.83			

An independent sample t-test was performed to compare whether there was difference between the posttest score of control & experimental group in subject of science. The results indicates that there is significant difference (t: 7.32; P: 0.000) between posttest score of control & experimental of students with visual impairment studying at grade 6th.

Table 8
Paired Sample t-test Comparing Pretest and Posttest Score of Control Group in subject of science

					95% Confidence Interval of the Difference				
Control	Test	N	Mean	SD	Lower	Upper	t	df	P
Group	Pretest Score	10	75.40	1.95	-0.426	2.26	1.53	9	0.159
	Posttest Score	10	76.50	1.84					

Paired sample t-test was used to compare the pretest and posttest score of control group in subject of science. No significant difference *(P:0.159)* was found between the pretest scores *(M:75.40)* and posttest scores *(M:76.50)* of control group.

Table 9
Paired Sample t-test Comparing Pretest and Posttest Score of Experimental Group in subject of science

					95% Confidence Interval of the Difference				
Experimental	Test	N	Mean	SD	Lower	Upper	t	df	P
Group	Pretest Score	10	82.50	1.96	-16.135	4.66	4.10	9	0.003
	Posttest Score	10	92.90	6.83					

Paired sample t-test was used to compare the pretest and posttest score of control group in subject of science. There was significant difference *(P:0.003)* between the pretest scores *(M:82.50)* and posttest scores *(M:92.90)* of experimental group. Experimental group performed better in posttest after the implementation of Instructional Package to Teach Science (IPTS).

Conclusions and Discussion

The findings indicated that students who received instruction in abstract concepts of science through ADDIE instructional design performed significantly better than those who received conventional teaching. After twelve-week intervention, post-test was conducted. Independent t-tests and paired sample t-tests were used to analyze the results. ADDIE instructional design instructional design is effective in enhancing the abstract concepts of science of SWVI. This approach should be considered in educational settings for teaching science concepts investigative skills and observation. Further research is needed to explore long-term impact and applicability to a wider range of individuals with vision limitation.

Science education is designed to involve students in the research process. Students' performance and abilities can be enhanced via science investigations. These are conducted by talking about these kinds of interactions in relation to exercises and firsthand observations meant to pique students' interest in science, observation, data collection, analysis, and conclusion-drawing. Kurniawan et al. (2011) highlighted that based on the findings of these studies; students will have a desire to learn in order to develop their critical thinking abilities in science-related courses. The ADDIE model has shown to be an extremely helpful instructional model for creating materials for traditional instruction, and it is highly intended to be used in the creation of electronic and online teaching resources. When the ADDIE Instructional Model was methodically applied to the development of a production-based model, there was also an increase in student learning outcomes as evidenced by the comparison of pre-test and post-test findings (Drljača et al., 2017; Adri et al., 2020).

It is determined that, prior to doing an experiment, every student possesses nearly identical abstract scientific knowledge.Even though the majority of students did well on the pre-test when it came to solving knowledge-level items, they struggled to solve comprehension-level items, scoring only average and performed below average when it came to solving application-level items.They were all incapable of solving analytical problems. This study brought to light a number of difficulties that both teachers and students with vision impairments had when teaching scientific subjects. It is challenging to teach and learn abstract ideas like cellular organization, photosynthesis, environmental connections, and space science. This conclusion is supported by literature, which argues that children with visual impairments have difficulties learning abstract concepts since they rely on visual aids and the subject matter is inherently complicated (Sahasrabudhe&Palvia, 2013: Sahin&Yorek, 2009).

The significant differences in the pre- and post-test results between the two groups demonstrate the effectiveness of the ADDIE instructional design in helping sixth-grade SWVI students grasp abstract scientific concepts. The pre- and post-test results between the experimental group and the control group were significantly different, highlighting the importance of the ADDIE instructional design for the development of abstract scientific notions. The ADDIE model is a suitable strategy for producing e-learning materials and is applicable for adult education, based on the opinions of participants regarding the visual, aural, and interaction characteristics comprising educational materials. Due to their liberty, adults prefer not to rely on the educational resources (Gökkaya&Güner, 2014).

When the findings of this study were compared between the two groups, the experimental group's student performance was shown to be statistically significant. Similarly, the efficacy of this design has been assessed (Alnajdi, 2018).

This experimental study assessed the beneficial effects of the ADDIE instructional design on SWVI academic success in the development of abstract concepts of science. Additionally, the ADDIE instructional design paradigm greatly improves the experimental group's post-test results. In terms of functional skills, it is more productive, effective, and efficient than the traditional teaching technique. Students are inspired and encouraged to participate fully in their studies as a result.

Findings revealed that there is a change in learning abstract concepts of science at grade 6th of SWVI taught with ADDIE instructional design versus conventional teaching. The current study adds to the body of literature by highlighting the significance of teaching abstract concepts of science toSWVI. It also emphasises the advantages of ADDIE instructional design, which mixes in-person and online instruction, for the instruction of life skills. ADDIE instructional design gives students a more interesting and individualised learning experience by incorporating technology and interactive activities. Findings: ADDIE instructional design was effective in teaching abstract concepts of science at grade 6th of SWVI.

Recommendations

- It is necessary to improve the availability of specialized software and resources in order to meet the educational requirements of visually impaired pupils.
- The study can be done on a larger sample size in future.
- The same intervention can be provided on science concepts and another detailed outcome can be evaluated.
- The government ought to hire educators who specialize in teaching science and provide them with the tools they need by regularly offering professional development opportunities.

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