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PAPER ON EDUCATION

Use of Contextualized Instructional Materials: The Case of Teaching Gas Laws in a Public Uptown High School

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Abstract:

The study determined the effectiveness of the use of contextualized instructional materials (CIM) in teaching Gas Laws. Two groups of tenth-grade students from a public uptown high school in Cebu City, Philippines participated in the study. The control group was exposed to the conventional lecture method (CLM) while the experimental group was exposed to CIM for a month in the fourth quarter of the school year. Study findings revealed that the CLM group had Below Average entry and exit performances, and the CIM group had Below Average entry and Average exit performances. Both groups had significant improvement from entry to exit performances. Results also showed that students exposed to CIM had significantly higher improvement than those exposed to CLM. Gender and age did not have any relationship with the improvement of CIM's performance. The study concluded that contextualized instructional materials were an efficient medium in achieving maximum learning potential as evidenced in students' enhanced performance in the concepts of Gas Laws in Chemistry. Workshops on making contextualized materials for teachers are recommended.

Keywords: age; contextualized instructional materials; conventional lecture method; Gas Laws; gender

1. Introduction

One of the key goals of Chemistry education is to let the teaching and learning be relevant both to the students and to the society in which they live [1]. However, most public schools were not involved in a concrete experience where they could acquire more meaningful and relevant learning experience due to the dearth of science facilities and equipment in basic educational institutions [2]. Due to this, Chemistry teachers intensify to augment this lack of materials by developing innovative pedagogies that realize the goal of Chemistry education. One of these interventions is the use of contextualization.

Contextualization is designed to seamlessly link the students' acquired knowledge and skills to concrete applications in context to their lives and interest [3]. In this way, they develop not only the content but also the procedural knowledge and metacognitive awareness of when and how to apply what has been learned [4]. This approach builds a learning community within the classroom and values knowledge and skills within the social context [5]. Through contextualization, context and culture take place [6]. Thus, the more novel material is contextualized, the more the students see its importance and utility, there is greater motivation to learn it.

One way of applying contextualization is the use of contextualized instructional materials (CIM) in Chemistry. Improved learning materials facilitate instruction whenever there is a lack or shortage of specific teaching aids [7]. The materials could increase class participation and performance among students [8]. This leads to a social activity in which students construct

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knowledge with their teacher and classmates [9]. Due to this, several studies have been conducted concerning Chemistry teaching and learning. Mboto et al. found out that such materials could improve the retentive abilities of students [10]. Otor et al. revealed that the learning materials led to better Chemistry achievement, and that gender is not a factor in using such materials [9]. Sagcal et al. showed that context-based laboratory activities and low-cost kits provided better learning in Chemistry and higher acceptability in public schools [11].

The use of CIMs has been reflected in the principles anchoring the enhanced basic education curriculum of the Philippines. Science teachers, including those in Chemistry education, shall commit to integrating contextualization, localization, and indigenization for a more enriched teaching-learning process. Anchoring on this principle as well as on the lack of laboratory materials in Philippine schools, the study aimed to develop an approach that uses contextualized, localized, and indigenized instructional materials that could be used by teachers to enrich the learning process and eventually increase students' performance. The results of this study would offer more opportunities to keep quality education while using improvised materials in place of non-existent laboratories in most schools. Hence, the conduct of the study.

2. Results and Discussion

The entry performance levels of students in the control group (exposed to conventional lecture method or *CLM*) and the experimental group (exposed to the use of contextualized instructional materials or *CIM*) were Below Average (Table 1). The exit performances of CLM and CIM groups were Below Average and Average levels, respectively. The entry performances could be due to students' lack of exposure to the concepts of Gas Laws that led to their difficulty in answering items. The exit performances may be due to the different teaching methods they were taught. In CLM, only the teacher did the lecture, discussion, and demonstrations with little or no participation of the students. In CIM, students were actively involved in the learning process and contextualized activities were used in the teaching process. The use of CIMs made substantial improvements in students' understanding [12] and motivated them to create connections between what they learned to what they can apply in their lives [13].

Table 1. Entry and exit performance levels of students in Chemistry.

Performance	Group	HM[1]	AM[1]	SD	*t*-value	p-value	Description
Entry	CLM	30	17.57	3.51	-24.051*	.000	Below Average
	CIM	30	16.54	3.07	-29.683*	.000	Below Average
Exit	CLM	30	28.37	1.95	-5.677*	.000	Below Average
	CIM	30	30.24	4.30	2.264[ns]	.028	Average

[1] Hypothetical mean based on 60% standard: 50x60%=30
[2] Actual mean based on the actual scores
* Significant at α=0.01; [ns] Not significant at α=0.01

Both CLM and CIM groups obtained significant mean improvement from the pretest to the posttest (Table 2). The significant improvement may be because students were already exposed to the concepts of Gas Laws and engaged in different activities. This also indicates both pedagogies were effective in significantly improving students' performance. Improvement in the CLM group may be attributed to the fact that the teacher was actively lecturing which helped students improve their performance. Improved performance in the CIM connotes that when students engaged in the learning tasks in context and by themselves, they became more motivated resulting in a good performance in the subject. The use of CIMS in Chemistry enables students to become actively involved intellectually, perceptually, and physically in the learning process [10].

The CIM group had a significantly higher mean gain than the CLM group (Table 3). The use of contextualized learning materials was more effective than the lecture method because the lab exercises and conceptual discussions were contextualized to the students' lives. The superiority of the use of such materials adheres to the standards and principles of the enhanced basic education curriculum in the Philippines that stated that the curriculum should be meaningful, responsive, culture-sensitive, and contextualized as mentioned in Republic Act 10533. Moreover, the act also states that the curriculum should be flexible enough to enable and allow schools to localize, indigenize, and enhance the teaching-learning process based on their respective educational and social contexts. This was evident in the application of CIMS, where the materials were locally produced and meaningful to their local conditions and environment [14].

Table 2. Mean gains in students' performance in Chemistry.

Group	Pretest Mean	Posttest Mean	Mean Gain	SD	*t*-value	p-value
CLM	17.57	28.37	10.80	4.05	18.080*	.000
CIM	16.54	30.24	14.89	4.94	20.442*	.000

* Significant at α=0.01

Table 3. Comparison of mean gains in students' performance in Chemistry.

Group	Mean Gain	SD	Difference between Means	*t*-value	p-value
CLM	10.80	4.05	4.09	4.338*	.000
CIM	14.89	4.94			

* Significant at α=0.01

The use of CIMs supported the findings of Mboto et al., which found out that the materials provide students with a concrete experience that they need to develop their intellect [10]. Otor et al. stated that contextualization has positive achievement because students were manipulating the actual/physical instructional materials [9]. Context-based activities and low-cost Chemistry kits were effective in increasing students' performance [11]. The authenticity of the use of CIMs targets one of the gold standards of authentic learning, that is, the immediate value of learning beyond the academic setting [15]. Therefore, authentic tasks should be employed in meaningful contexts for students to construct relevant and important applications out of such meaning [16]. As evident in the use of lab materials and context-based activities, students were able to integrate learning contexts in a form of drawing realistic connections, making learning meaningful, and forming connections within and between content domains, such as everyday experiences and complex problem-solving activities in gas laws [17].

The study affirmed Bruner's notion that constructivist learning environments are multiple representations of reality, which was evident in the use of contextualized, improvised, and localized learning materials in the experiment and classroom activities to view different perspectives of the gas laws [18]. These multiple representations avoid oversimplification and represent the complexity of the real world, as shown in the students' way of handling the CIMs. They understood the underlying principle behind a phenomenon that in reality is a complex scientific one. Placing learning within a meaningful and problem-solving context is important [19].

Gender and age did not have significant correlations with the performance of the CIM group (Table 4). This means that gender and age do not dictate the performance derived from the use of contextualized instructional materials. Being male or female or being younger or old does not have a bearing in the utilization of such materials, and eventually, achievement derived from such use.

Table 4. Association of gender and age in CIM performances.

Variables	r-value	p-value	R^2
Gender and Chemistry performance	-0.261^{ns}	.080	0.068
Age and Chemistry performance	0.069^{ns}	.651	0.005

^{ns} Not significant at α=0.01

Trends in Chemistry achievement revealed that males and females performed equally well as it pertained to courses in the K to 12 level and performances in the classroom under a fair and conducive instructional context [9, 20]. Age is found to have no significant effect on academic performance [21, 22].

3. Material and Methods

The study used quasi-experimental research with pretest/posttest control group design to determine the effectiveness of CIMs in teaching Gas Laws to tenth-grade students in a public high school institution in the uptown areas of the Division of Cebu City in Region VII, Philippines. In this institution, there were 119 tenth graders. Using Slovin's formula (N=119, e=.05), 92 students participated in the study; 46 of them composed the control group (exposed to CLM) while the other 46 were included in the experimental group (exposed to CIM). Both groups had comparable entry Chemistry performances (t=1.486, p=.070). There were more male students than female ones; most of them were aged 15 years old (Table 5).

Table 5. Gender and ages of the tenth-grade participants.

Age	Control (*n*=46)				Experimental (*n*=46)				Total (*n*=92)			
	Male		Female		Male		Female		Male		Female	
15 years old	14	30%	10	22%	14	30%	12	26%	28	30%	22	24%
16 years old	8	17%	10	22%	10	22%	7	15%	18	20%	17	18%
17 years old	4	7%	0	0	3	7%	0	0	4	4%	3	3%
Total (*n*=92)	26	57%	20	43%	27	59%	19	41%	50	54%	42	46%

The researchers asked permission from the Division Office and Principal's Office to conduct the study in the said institution. Then, they asked for informed consent from the study participants for their possible participation in the experimentation. Once permissions were all set, pretesting was done. The pretest/posttest tool is a validated 50-item multiple-choice assessment tool based on unified test questions provided by the division office. The items are divided into five sections, each corresponding to a gas law: Boyle's, Charles's, Gay-Lussac's, Dalton's, and Combined Gas laws.

After pretesting, the control and experimental groups were subjected to experimentation for a month in the fourth quarter of the school year. The former was exposed to CLM while the latter was exposed to CIM. In the CLM, the teacher is the sole lecturer of imparting knowledge and skills to students. The teacher does not only discuss but also demonstrates experiments in front of the class. The lecturer then proceeds to explaining the gas laws and solving problems relating to such scientific laws. Clarifications follow and generalization ends the lesson.

The use of CIMs follows the Integrated Macro-Micro-Symbolic Approach [23] but the activities were all contextualized. In this approach, the students are involved in springboard activities that lead to the presentation of the lesson in hand. Then, they are exposed to experiment activities utilizing contextualized materials and setup. Sample contextualized materials are found in Table 6.

After the activities, they are involved in discussions at the particulate level using improvised models, and in problem-solving tasks using context-based problems in gas laws. Clarifications and generalization follow and end the lesson. Post testing was done after the month-long experimentation. Data derived from the investigation were summarized using descriptive statistics such as mean and standard deviation (SD). Inferential statistical tools such as t-tests were employed to determine the entry and exit performance levels (t-test for single samples), the mean improvement from entry to exit performances (t-test for dependent samples), and the comparison of the mean gains (t-test for independent samples). Pearson r correlational analysis was used to determine the relationship between gender, ages, and mean gains. All tests were conducted at a 99% confidence level, and p-values less than .01 are considered significant.

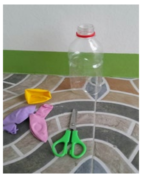
Throughout the study, research ethics concerning human subjects was observed. Proper research correspondence and informed consent were obtained before conducting the study. The gathered data were stored in a password-protected file. All data were kept confidential, and the names were written anonymously.

Table 6. Sample contextualized materials.

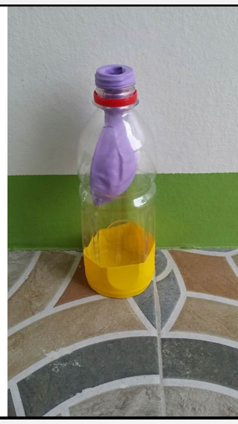
Sample experiment 1: Balloon in a Bottle

Objective: To show experimentally how Boyle's Law works.

Materials:



Exp. setup



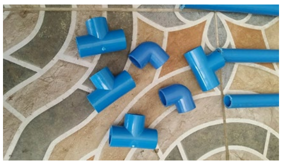
Explanation:

Boyle's Law states that at a constant temperature, the pressure and volume are inversely proportional to each other. Pulling the balloon at the bottom of the plastic bottle, the balloon inside the bottle inflated. Pulling the balloon at the bottom decreases the pressure causing the volume of the balloon inside the bottle to increase in size.

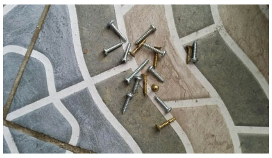
Sample experiment 2: Comparing moles of gases

Objective: To show experimentally how Ideal Gas Law works.

Materials:

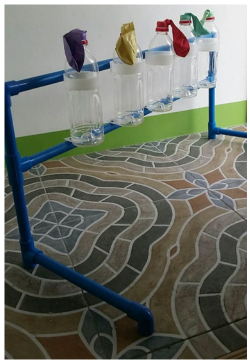


Used pipes

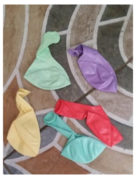


Used screws

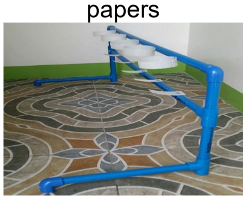
Paper bands from scratch papers



Recycled bottles



Used balloons



Exp. setup

Explanation:

For a given mass of an Ideal gas, the volume and amount (moles) of the gas are directly proportional if the temperature and pressure are constant.

4. Conclusions

Based on the findings of the study, contextualized instructional materials were efficient tools in achieving maximum learning potential as evidenced in students' enhanced performance in the concepts of Gas Laws in Chemistry. Learning concepts and principles of Gas Laws require not only knowledge and skills, but also an appreciation in real-life. As such, teaching the Gas Laws should be contextualized to students' needs, environment, and culture to make lessons on Chemistry significant and meaningful that can lead to a better way of understanding and finding solutions to real-life situations. The learning environment should provide multiple representations of reality through contextualized learning materials, placing students' learning in a meaningful and problem-solving context for optimum cognitive development.

The study recommends that teachers construct contextualized instructional materials relevant to students' needs, interests, and abilities, and use these materials in teaching Chemistry and other science disciplines. Education executives should organize seminar-workshops for teachers across grade levels that will capacitate the latter with appropriate knowledge, skills, and attitudes about contextualization, localization, and indigenization of activities that relate to real life and lifelong learning. Future researchers may use the study results as baseline data and venture more on how to improve Chemistry teaching amidst the new generation of learnings in the new normal.

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