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Contextualized Science Learning Tasks and Conceptual Transfer in Secondary Classrooms

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ABSTRACT

This study investigated how contextualized science learning tasks supported conceptual transfer among Grade 10 learners in a public secondary school in Tabuk City, Kalinga. Using a matched-intact-class delayed-transfer design, 60 learners were assigned by class to contextualized-task and comparison conditions. Data were gathered through the Contextualized Science Learning Tasks Scale and the Contextualized Science Learning and Conceptual Transfer Assessment, which measured near, intermediate, and far transfer across baseline, immediate, and delayed assessments. Results showed that learners rated the contextualized tasks positively, with local and experiential relevance obtaining the highest mean, while cross-context task variation received the lowest. Despite this, cross-context task variation showed the strongest association with delayed conceptual transfer. Learners exposed to contextualized tasks demonstrated greater gains than the comparison group from baseline to immediate assessment and maintained a substantial advantage after two weeks. Mixed-effects analysis confirmed significant condition-by-time interactions for overall transfer and across near, intermediate, and far transfer levels. Far transfer remained the most difficult, indicating that learners continued to struggle when new problems differed substantially from instructional examples. The findings suggest that contextualized science learning is most effective when familiar situations are combined with inquiry, reflection, and progressively varied applications. Secondary Science instruction should therefore move beyond relevance alone and provide repeated opportunities for learners to apply scientific concepts across changing situations to strengthen durable and flexible understanding.

Keywords: *conceptual transfer, contextualized learning, grade 10 learners, science education, secondary classrooms, transfer tasks*

INTRODUCTION

Science learning becomes more valuable when students can use what they have learned beyond the lesson in which it was introduced. Knowing scientific facts and procedures remains important, but meaningful science education also requires learners to explain phenomena, interpret evidence, and apply scientific ideas to situations that may differ from classroom examples. The Programme for International Student Assessment reflects this expectation by defining scientific literacy around the capacity to engage with science-related issues and use scientific knowledge across personal, local, and global situations (Organisation for Economic Co-operation and Development [OECD], 2023). This places greater importance on classroom experiences that develop understanding students can carry from one problem or setting to another.

One approach that supports this purpose is contextualized learning, where scientific concepts are connected with situations, experiences, materials, and problems that learners recognize as meaningful. Context-based approaches can provide a clearer purpose for learning because students encounter scientific ideas as tools for understanding situations rather than as isolated content to be memorized. Sevian et al. (2018) explained that context-based learning in science and STEM can shape students' engagement with both the subject matter and the situations through which concepts are learned. In Philippine basic education, this principle is also embedded in curriculum policy, which describes contextualization as relating curriculum content and instructional strategies to learners' experiences, interests, and surrounding communities so that learning becomes relevant and useful (Department of Education [DepEd], 2016).

Relevance alone, however, does not guarantee that students will develop flexible scientific understanding. An important outcome is conceptual transfer, or the ability to recognize and apply a learned concept when the problem, example, or setting changes. Research on learning emphasizes that deeper understanding involves extending knowledge beyond the narrow conditions under which it was first acquired and recognizing the underlying principles that connect different situations (National Academies of Sciences, Engineering, and Medicine [NASEM], 2018). This process can be difficult for learners because they may remember a concept yet fail to recognize its usefulness when surface features change. Kaminske et al. (2020) noted that successful transfer requires learners to recognize the relevance of previous knowledge, retrieve it accurately, and apply it appropriately to a new situation.

The design of contextualized tasks therefore matters. Exposure to familiar examples may help students understand an initial lesson, but transfer is more likely to develop when learners encounter scientific concepts across varied situations and are guided to identify the ideas shared by those situations. In an investigation of context-based learning involving the scientific concept of energy, Podschuweit and Bernholt (2018) found that learning through a more heterogeneous set of contexts supported transfer to new contexts more effectively than learning through a more homogeneous set. Such findings suggest that contextualized science tasks should not merely make lessons locally familiar. They should also provide opportunities for learners to reason across examples, connect scientific principles, and use those principles when conditions change.

This concern is particularly relevant to Philippine secondary science education, where many learners continue to encounter difficulty applying scientific knowledge. PISA 2022 reported that only 23% of Filipino students reached at least Level 2 proficiency in science, compared with 76% across OECD countries, indicating substantial difficulty in using basic scientific knowledge and reasoning even in relatively familiar situations (OECD, 2023). Against this educational concern, the present study examines Contextualized Science Learning Tasks and Conceptual Transfer in Secondary Classrooms among secondary Science learners at Kalinga National High School. It seeks to determine how learning tasks grounded in meaningful situations relate to learners' capacity to carry scientific concepts into different problems and applications. By focusing on conceptual transfer rather than classroom performance alone, the study may provide evidence for designing science learning experiences that are relevant to students while also preparing them to use scientific understanding more flexibly.

Literature Review

Contextualized Science Learning Tasks

Contextualized science learning places scientific ideas within situations that learners can connect with everyday experiences, community concerns, environmental conditions, and observable phenomena. Such tasks can make abstract concepts more accessible because students are given a recognizable situation through which scientific principles can be examined and applied. Suryawati and Osman (2018) found that contextual teaching and learning produced significant differences in science achievement among junior secondary learners, suggesting that meaningful connections between lesson content and experience can strengthen learning performance. Philippine evidence points in the same direction. A meta-analysis of local studies by Picardal and Sanchez (2022) found an overall positive effect of contextualized science instruction on student achievement, with most of the reviewed research conducted at the secondary level. These findings support the use of contextualized tasks not simply as supplementary activities, but as purposeful learning experiences through which students can interpret scientific ideas in situations that carry practical meaning.

Conceptual Understanding Through Meaningful Application

A contextualized task is most useful when it directs attention beyond the visible situation toward the scientific concept that explains it. Students may successfully complete an activity without necessarily recognizing the principle that makes the activity scientifically meaningful. Chase et al. (2019) demonstrated this distinction when they examined learners working on engineering tasks involving scientific principles. Their findings showed that learners who noticed the deeper scientific structure performed better and were more capable of applying the concept to other situations. The use of contrasting cases was particularly helpful because differences among examples directed learners toward features that remained scientifically important despite changes in surface details. For secondary science instruction, this suggests that contextualized activities should invite learners to explain why outcomes occur, compare cases, identify patterns, and connect observations with underlying concepts rather than focus only on producing a correct answer or completing a practical task.

Conceptual Transfer Across Scientific Situations

Conceptual transfer becomes visible when learners can use previously developed understanding in a situation that is not identical to the original learning experience. The degree of difference between situations can influence whether transfer occurs. Khishfe (2019), working with Grade 7 students, found that learners were more successful in transferring understandings when new situations were similar to the original learning setting or familiar through prior knowledge. The findings point to an important consideration in science task design: students may need structured opportunities to move progressively from familiar applications toward less familiar ones. Conceptual transfer should therefore not be treated as an automatic consequence of understanding a lesson. It requires learners to recognize that the same scientific principle remains applicable even when the objects, circumstances, or problem features change. This distinction is central to the present study because it shifts attention from whether learners know a scientific concept to whether they can use that concept beyond the task through which it was initially learned.

Task Variation and Evidence of Transfer

Measuring conceptual transfer requires tasks that retain the scientific idea being assessed while changing the phenomenon or situation in which learners must use it. Penuel et al. (2019) developed proximal transfer tasks for high school biology in which students encountered phenomena related to, but distinct from, those studied during instruction. Their work with 733 learners showed significant growth across most pretest and posttest task pairs, while also revealing that task difficulty varied depending on the phenomenon presented. This finding has an important methodological implication: transfer cannot be established simply by repeating classroom questions using slightly altered wording. Learners need opportunities to demonstrate understanding through new applications that preserve the target concept while changing contextual features. For contextualized science learning, varied tasks can therefore serve two purposes. They can build flexibility during instruction and provide stronger evidence of whether students can carry scientific understanding from one situation to another.

METHODS

Research Design

The study used a matched-intact-class delayed-transfer design to determine whether contextualized science learning tasks improved learners' ability to apply scientific concepts to situations different from those encountered during instruction. Two existing Grade 10 classes participated under comparable instructional conditions. One class received contextualized learning tasks, while the other completed curriculum-aligned science activities covering the same competencies and instructional duration. Conceptual transfer was measured before instruction, immediately after the intervention, and again two weeks later. The third measurement was included to determine whether learners retained the ability to use scientific concepts after the immediate effects of instruction had diminished.

Research Locale

The study was conducted at Kalinga National High School in Tabuk City, Kalinga. The school served learners from communities where environmental, agricultural, household, health, and technological situations could be meaningfully incorporated into secondary Science lessons. These conditions provided an appropriate setting for examining whether locally meaningful learning situations could support the movement of scientific understanding from familiar classroom tasks to new applications.

Participants and Sampling Technique

The participants were 60 Grade 10 Science learners drawn from two intact classes, with 30 learners in each class. Grade 10 learners were selected because they had sufficient exposure to foundational scientific concepts and were capable of completing application and transfer tasks requiring explanation and reasoning. Matched intact-class sampling was applied. The two classes were selected based on comparable previous Science performance and were assigned to the contextualized-task and comparison conditions. Learners were included in the final analysis only when they completed the baseline, immediate-transfer, and delayed-transfer assessments.

Research Instrument

The study employed the researcher-developed Contextualized Science Learning and Conceptual Transfer Assessment (CSLCTA) to measure learners' ability to apply scientific understanding across increasingly unfamiliar situations. The assessment contained 24 items distributed equally across three levels of transfer: near, intermediate, and far transfer. Near-transfer tasks presented situations closely related to those encountered during instruction, intermediate-transfer tasks modified important features of the original learning context, and far-transfer tasks required learners to apply the same scientific principle to substantially different situations. Responses were scored from 0 to 2 based on conceptual accuracy, appropriateness of application, and quality of reasoning, resulting in a maximum possible score of 48.

Content validation was conducted by five experts in Science education, curriculum development, educational measurement, and research methodology. They evaluated each item for relevance, clarity, contextual suitability, and correspondence with the intended transfer level. The assessment obtained an S-CVI/Ave of .93, with item-level content validity indices ranging from .80 to 1.00. Based on the experts' recommendations, several items were refined to improve contextual clarity and ensure clearer distinctions among the three transfer levels.

Following validation, the revised CSLCTA was pilot tested with 35 Grade 10 learners who were excluded from the main study. Reliability analysis produced Cronbach's alpha coefficients of .86 for near transfer, .84 for intermediate transfer, and .82 for far transfer, with an overall Cronbach's alpha of .90 for the complete assessment. Since responses involved judgment of learners' written reasoning, two independent raters also scored a portion of the pilot responses using the established scoring criteria. The resulting intraclass correlation coefficient of .93 demonstrated a high level of inter-rater consistency. These findings established adequate content validity, internal consistency, and scoring reliability for the use of the CSLCTA in the main assessment.

Data Gathering

Approval was secured from the appropriate education and school authorities before implementation. Written parental consent and learner assent were obtained before participation. Both classes first completed the baseline conceptual transfer assessment. The intervention class then completed eight contextualized Science learning tasks integrated into regular lessons, while the comparison class studied the same competencies through regular curriculum-aligned activities. The instructional period, targeted concepts, and assessment schedule were kept comparable between groups. The immediate-transfer assessment was administered after completion of the instructional sequence, followed by a parallel delayed-transfer assessment 14 days later. Learner codes were used to connect the three sets of scores without placing names on the research database.

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Data Analysis

The analysis used a mixed-effects growth model to examine changes in conceptual transfer across the three measurement occasions. Time, instructional condition, and the interaction between time and instructional condition were entered as fixed effects, while individual learner differences were modeled as random effects. The interaction term determined whether learners exposed to contextualized tasks followed a different pattern of transfer development from those in the comparison class. Separate models were subsequently estimated for near, intermediate, and far transfer to determine whether the instructional effect changed as the distance between the learned and new situations increased. Estimated marginal means were compared using Holm-adjusted pairwise contrasts. Hedges' g with 95% confidence intervals was reported to indicate the magnitude of between-group differences. Statistical decisions were made at the .05 level of significance.

Ethical Consideration

The study observed voluntary participation, informed parental consent, learner assent, confidentiality, and the right to withdraw without academic consequence. Participation did not affect learners' grades, classroom privileges, or access to instruction. Research records were coded and securely maintained, and findings were reported collectively to prevent identification of individual participants.

RESULTS AND DISCUSSION

Table 1. *Learners' Assessment of Contextualized Science Learning Tasks*

Dimension	Mean	SD	Rank
Local and Experiential Relevance	4.31	0.46	1
Real-World Problem Orientation	4.18	0.49	2
Inquiry and Evidence Use	4.06	0.52	3
Reflective Concept Application	3.97	0.54	4
Cross-Context Task Variation	3.88	0.55	5
Overall	4.08	0.43	

The overall mean of 4.08 indicated that learners generally experienced the contextualized science tasks as relevant, application-oriented, and connected with situations beyond textbook presentation. Local and experiential relevance obtained the highest mean of 4.31, showing that learners were most responsive when scientific concepts were linked with situations they recognized from everyday life, community practices, environmental conditions, and familiar experiences. Real-world problem orientation followed with a mean of 4.18, suggesting that the tasks provided clear reasons for using scientific knowledge rather than presenting concepts as isolated academic content.

The lower ratings for reflective concept application, M = 3.97, and cross-context task variation, M = 3.88, revealed an important instructional concern. Although learners could connect science with familiar situations, transferring the same concept across substantially different problems was more demanding. The findings suggest that contextualization worked most readily when learners recognized the setting, but additional scaffolding was required when the task shifted from familiarity toward abstraction and application across less familiar circumstances. Thus, the quality of contextualized instruction depended not only on making examples locally meaningful but also on gradually varying the conditions under which scientific concepts were applied.

Table 2. *Overall Conceptual Transfer Performance of the Two Groups*

Group	Baseline M	SD	Immediate M	SD	Delayed M	SD	Baseline to Immediate Gain	Baseline to Delayed Gain

Contextualized-task group	24.60	4.80 36.80	4.50 34.90	4.70 12.20	10.30
Comparison group	24.20	5.00 30.70	4.90 28.60	5.10 6.50	4.40

Maximum score = 48.

Both groups began with comparable conceptual transfer scores. The contextualized-task group recorded a baseline mean of 24.60, while the comparison group obtained 24.20. A marked difference emerged after instruction. Learners exposed to contextualized science tasks increased to 36.80, producing a gain of 12.20 points. The comparison group also improved, although its gain was limited to 6.50 points.

Some decline occurred after the two-week interval. The contextualized-task group decreased from 36.80 to 34.90, while the comparison group declined from 30.70 to 28.60. Despite this loss, the contextualized group retained a 10.30-point improvement from baseline compared with 4.40 points in the comparison group. The decline indicates that transfer weakened when learners were no longer receiving continuous instructional support. However, the substantially higher delayed score among learners who completed contextualized tasks suggests that these experiences produced more durable conceptual connections.

Table 3. *Conceptual Transfer According to Transfer Distance*

Transfer Level	Group	Baseline M	SD	Immediate M	SD	Delayed M	SD
Near Transfer	Contextualized	8.80	1.70	13.20	1.50	12.70	1.60
	Comparison	8.70	1.80	11.40	1.70	10.80	1.80
Intermediate Transfer	Contextualized	8.20	1.80	12.50	1.60	11.80	1.70
	Comparison	8.00	1.90	10.30	1.80	9.50	1.90
Far Transfer	Contextualized	7.60	1.90	11.10	1.80	10.40	1.90
	Comparison	7.50	1.90	9.00	1.90	8.30	2.00

Maximum score for each transfer level = 16.

The results revealed a clear transfer gradient. Performance was highest for near transfer, followed by intermediate transfer, while far transfer remained the most difficult area in both groups. Among contextualized-task learners, delayed means decreased from 12.70 for near transfer to 11.80 for intermediate transfer and 10.40 for far transfer. This pattern showed that learners became less successful as assessment situations differed more substantially from those used during instruction.

The contextualized group nevertheless maintained an advantage across all three levels. The pattern suggests that exposure to meaningful and varied science tasks strengthened learners' ability to recognize scientific principles even when task features changed. The remaining weakness in far transfer is equally important. Learners were still more comfortable applying knowledge when recognizable features were retained. This finding reinforces the need for contextualized tasks that progressively move from familiar situations toward problems whose surface features differ but whose scientific principles remain the same.

Table 4. *Mixed-Effects Growth Model for Overall Conceptual Transfer*

Fixed Effect	B	SE	95% CI	t	p
Intercept	24.20	0.90	22.44, 25.96	26.89	<.001
Contextualized-task condition	0.40	1.25	-2.05, 2.85	0.32	.750
Immediate assessment	6.50	0.72	5.09, 7.91	9.03	<.001
Delayed assessment	4.40	0.72	2.99, 5.81	6.11	<.001
Contextualized × Immediate	5.70	1.02	3.70, 7.70	5.59	<.001
Contextualized × Delayed	5.90	1.02	3.90, 7.90	5.78	<.001

The absence of a significant baseline difference, B = 0.40, $p = .750$, showed that the groups entered the study with comparable conceptual transfer performance. The significant time effects indicated that learners in both conditions improved after instruction. More importantly, the interaction effects were significant at both immediate and delayed assessment.

The contextualized-task group gained an additional 5.70 points beyond the change observed in the comparison group immediately after instruction, $p < .001$. The delayed interaction remained significant, B = 5.90, $p < .001$. The result showed that contextualized science learning tasks were associated with stronger development and retention of conceptual transfer rather than merely higher scores at one assessment point. The persistence of the effect after two weeks indicates that the benefit extended beyond immediate familiarity with recently completed classroom activities.

Table 5. *Association Between Contextualized Science Learning Task Dimensions and Delayed Conceptual Transfer*

Contextualized Task Dimension	r	p
Local and Experiential Relevance	.42	.021
Real-World Problem Orientation	.51	.004
Inquiry and Evidence Use	.58	<.001
Reflective Concept Application	.63	<.001
Cross-Context Task Variation	.69	<.001
Overall Contextualized Task Score	.66	<.001

Although local and experiential relevance received the highest descriptive rating, it did not show the strongest relationship with delayed conceptual transfer. Its correlation with delayed performance was moderate, $r = .42$. In contrast, cross-context task variation showed the strongest association, $r = .69$, followed by reflective concept application, $r = .63$, and inquiry and evidence use, $r = .58$. The overall contextualized task score was also strongly associated with delayed conceptual transfer, $r = .66$, $p < .001$.

This result provides an important distinction. Learners valued tasks that were familiar and locally relevant, but the elements most closely connected with transfer were those requiring them to apply concepts repeatedly under changing conditions. Familiarity therefore appeared to support entry into the learning process, while variation, reflection, and evidence-based reasoning were more closely tied to the capacity to use knowledge beyond the original lesson.

Table 6. *Regression Model Predicting Delayed Conceptual Transfer*

Predictor	B	SE	β	t	p
Constant	6.21	2.17		2.86	.008
Overall Contextualized Task Score	7.03	1.46	.66	4.82	<.001

Model Statistic	Value
R	.66
R^2	.44
Adjusted R^2	.42
F	23.23
p	<.001

The overall contextualized science learning task score significantly predicted delayed conceptual transfer, $\beta = .66$, $p < .001$. The model explained 44% of the variance in delayed transfer scores. This means that differences in how strongly learners experienced the tasks as contextualized, inquiry-oriented, reflective, and varied were meaningfully associated with their later ability to apply scientific concepts.

The remaining 56% of unexplained variance indicates that conceptual transfer was not determined by contextualization alone. Prior knowledge, reasoning ability, retrieval strength, reading demands, and individual differences may also have influenced performance. Nevertheless, the magnitude of the explained variance supports the instructional importance of well-designed contextualized tasks. The findings indicate that contextualization was most productive when it moved beyond making Science familiar and instead required learners to reason with scientific concepts across increasingly different situations.

Overall, the results established a coherent relationship between the two central variables of the study. Contextualized Science Learning Tasks were positively experienced by learners and significantly contributed to the development of Conceptual Transfer. The strongest benefit appeared when tasks incorporated variation, reflective application, and evidence-based reasoning. At the same time, far transfer and delayed retention remained areas of difficulty, showing that conceptual flexibility required sustained and progressively varied learning opportunities.

CONCLUSION

contextualized science learning tasks strengthened conceptual transfer among Grade 10 learners, particularly when activities incorporated meaningful situations, inquiry, reflective application, and varied problem settings. Learners exposed to contextualized tasks demonstrated greater immediate and delayed transfer than those who received regular curriculum-aligned activities, although far transfer remained more difficult than near and intermediate transfer. Cross-context task variation and reflective concept application emerged as the dimensions most strongly associated with delayed transfer, indicating that familiarity alone was insufficient for developing flexible scientific understanding. It is therefore recommended that secondary Science teachers design learning tasks that begin with recognizable local or everyday situations and progressively introduce less familiar applications that require learners to identify and use the same scientific principle under changing conditions. Science instruction should also provide repeated opportunities for explanation, evidence-based reasoning, retrieval, and delayed application so that conceptual understanding is retained beyond the lesson. Schools may support this practice through collaborative task development, classroom-based assessment of transfer, and professional learning activities focused on contextualized and application-oriented Science pedagogy.

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