A Discussion

According to our benchmark results, there is still a lot of space for improvement in low-resource languages like Dzongkha for LLMs like ChatGPT. One noteworthy finding is that it is far more difficult to guarantee that the model outputs follow a specified structure for automated assessment in Dzongkha. Improving multilingual models' ability to follow instructions should be the main focus of future research.

The significant performance difference between proprietary and open-source language models is another important conclusion. To compete with proprietary models, open-source models—which are more widely available in poorer nations—need to make substantial progress. This is necessary to make sure that no one group of people is excluded from the advantages of AI, especially LLMs. A recently published open multilingual LLM, Aya [31], represents a promising step in this direction.

We also showed that it is possible to use query translation to have LLMs answer in the target language while utilizing the benefits of high-resource languages, like English, in the inference pipeline. This method's advantage is that it does not need access to personally produced premium translations, as this study did; translations produced by the same model or more potent/specialized models can serve just as well. But the translation technique—whether it's a domain-specific, fine-tuned translation model or another skilled LLM—can affect performance. This result emphasizes how much more study is required to maximize and improve the usage of LLMs, especially for low-resource languages.

B Limitations

It is important to note that our work has various limitations. First, we removed figure-based questions from our dataset during curation, thus it mostly consists of text-based questions. Given that visual issues frequently call for more sophisticated thinking, this constraint could limit the breadth of our findings. Furthermore, because the questions are multiple-choice, there's a chance that models may skip some of the answers, particularly for factual questions that don't call for sophisticated thinking. For evaluating LLMs in Dzongkha, where resources for knowledge-intensive and question-answering duties are currently scarce, our dataset is a valuable starting point despite these drawbacks.

C Further Tests

Here, we carry out further tests to see if using more effective prompting techniques will enhance Dzongkha performance. For Dzongkha, GPT-3.5 provides a decent mix between cost-effectiveness and capacity, and it was used for all of the trials discussed here.

C.1 Performance on Adding English Translation

We speculate that two primary reasons for the poor performance of models in Dzongkha might be their lack of knowledge of Dzongkha scientific terms and possible challenges in deciphering non-Latin characters [17]. We anticipate that giving the query an English translation will aid the model in comprehending the context. We experimented on a randomly chosen subset of 105 data points from each participant in the 10th-grade exam questions in order to test this hypothesis. Because they fall somewhere in the center of difficulty when compared to problems from the eighth and twelfth grades, the tenth grade questions were selected.

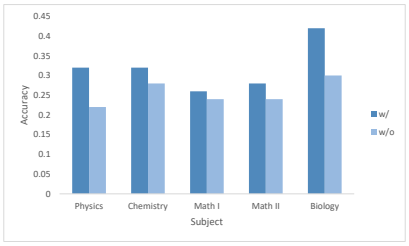

Figure 7: Answering questions in Dzongkha is made easier by including an English translation. Note that w/ denotes with and w/o denotes without including the translation. The model was requested to do CoT in Dzongkha.

Findings Figure 7 illustrates how adding English translations improves performance in every topic. The system prompts were always in English throughout our work. This experiment verified that the performance improvement is due to the attached translations by providing the questions in Dzongkha together with their English translations. In biology, where scientific vocabulary is widely used, the most improvement was shown. The gain in math, however, was not as noticeable. Additionally, we tested LLM-generated translations in place of human translations, and preliminary findings indicate that they could function similarly. Additional information can be found in Section 6.3.

C.2 Performance of Translation-appended Prompting Strategy to Different Datasets

To assess the suitability of our prompting approach on a variety of datasets, we expanded our trials to include Big-Bench-Hard.

Big-Bench-Hard Dzongkha We used GPT-4 to create a Dzongkha version of the Big-Bench Hard (BBH-DZ) dataset for this experiment. We chose activities from Big-Bench Hard that demand reasoning and are relevant to Dzongkha since only 11% of the DZEN tests require reasoning abilities. Due to the possibility of irregularities in the alphabetical order after translation, tasks such as word sorting were not included. Prompts for each challenge were iteratively created by two native Dzongkha speakers.

When premium English translations were added, our tests revealed an average performance gain of 6.52% in BBH-DZ, while GPT-4-generated translations produced an average improvement of 6.05%. Additional information on the findings and task choices can be found in Appendix F.

D Grammar Errors' Impact on DZEN

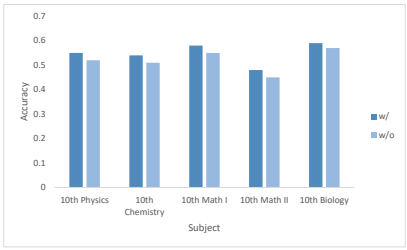

Figure 8: Grammatical errors' effects on GPT 3.5 performance. Note that w/ denotes with and w/o denotes without including grammar fixed.

In order to observe the impact of minor grammatical errors and strange English translations, we chose 115 questions from every 10th grade subject. We asked GPT-4 to correct any grammatical errors and strange translations. After reviewing the findings, a native Dzongkha speaker who was fluent in English made the required revisions[4] to the GPT-4. Figure 8 shows how well GPT-3.5 performed on this portion of the dataset. There is very little difference between the version with and without grammatical faults, and a manual examination of Figure 8 showed a little disparity that resulted from the stochastic nature of GPT-3.5 rather than any grammar issues.

[4] We did not utilize this procedure to repair grammar for the whole dataset since GPT-4 frequently changes the question's original meaning while fixing grammar.

E Results for Intermediate CoT

Table 4: Test of correctness of CoT procedures and the final answer. Note that w/ denotes with and w/o denotes without including English translation. The intermediate levels of reasoning were completed in Dzongkha in each instance.

	Final Answer	
	✓	×
w/		
CoT ✓	25	3
CoT ×	2	28
w/o		
CoT ✓	18	0
CoT ×	3	32

Table 4 displays the results of our human evaluations of a subset of the responses. The main findings are that the model's final response is incorrect when the CoT is incorrect and correct when the CoT is correct. There are very few cases where the model inadvertently uses the incorrect CoT steps to arrive at the correct answer.

F Further Tests on BIG-Bench-Hard

Alteration of Prompt

We explore four possible variations of the prompting method in Table 5.

Table 5: Prompt variations.

Condition	**Description**
Dzongkha	Asking only in Dzongkha.
Dzongkha + English (GPT-3.5)	Asking in Dzongkha and appending the English translation done by GPT-3.5.
Dzongkha + English (GPT-4)	Asking in Dzongkha and appending the English translation done by GPT-4.
Dzongkha + English (Premium)	Asking in Dzongkha and appending the English version from the original data.

F.1 Task Selection

From the 23 datasets officially published by BIG-Bench Hard, we selected 14 tasks that can have equivalence in Dzongkha[5]. The tasks we selected for our

[5] There isn't a direct "translation" in Dzongkha for certain BBH tasks, such as manipulating English alphabet letters.

work included: Reasoning About Colored Objects, Web of Lies, Multistep Arithmetic, Navigate, Object Counting, Penguin in a Table, Causal Judgement, Date Understanding, Disambiguation QA, Formal Fallacies, Logical Deductions Five, Seven, Three, and Multistep Arithmetic.

GPT-4 was used to translate these 14 tasks into Dzongkha, with three human-annotated examples serving as prompts for each task. Two Dzongkha speakers iteratively created the prompts to reflect the specifics of each job.

F.2 Findings

The outcomes of adding English translations to Big-Bench-Hard experiments are displayed in Table 9. The performance was marginally harmed in three instances, while it was beneficial in seven of the fourteen. Performance was essentially unchanged in the other four circumstances.

G Experimental Prompts

This section contains all the original prompts used for all the experiments.

G.1 Prepared DZEN Questions with Correct Grammar

We use the prompt in Figure 9 to correct the grammar of the original English questions using GPT-4.

G.2 Dataset Categorization for DZEN

As previously stated in Section 3.2, we used GPT-4 to categorize our dataset questions into three groups: Factual Knowledge, Procedural & Application, and Reasoning. To classify them, we utilize the prompt provided in Figure 10.

We use a zero-shot strategy with the categorization prompt for every question in the dataset. In tabular visualization, the subject-wise question category is represented by Table 6.

G.3 Prompting CoT for DZEN Zero-shot Benchmark

The prompt for zero-shot benchmarking with the proprietary models is displayed in Figure 11.

Prompting CoT for DZEN Few-shot Benchmark

We use the prompt in Figure 12 to do few-shot benchmarking using the proprietary models.

G.4 Translation Appended Benchmark Prompt

In the translation-append experiment, as explained in Appendix F, we limit the model to only reasoning in English by using the question displayed in Figure 13.

H Statistics that Benchmark

Benchmark results for the types and datasets we used for our experiments are shown in this section.

H.1 DZEN Zero-shot Benchmark

The zero-shot benchmark results on DZEN are displayed in Table 7.

H.2 Benchmark for DZEN Few-shot with and without CoT Reasoning

The few-shot benchmark results on DZEN with and without CoT reasoning are displayed in Table 8.

H.3 Benchmark for BIG-Bench-Hard Zero-shot

The zero-shot benchmark results on a few chosen reasoning-based BIG-Bench-Hard datasets are displayed in Table 9.

I Samples of DZEN Questions

Figures 14, 15, 16 & 17 provide a few examples from the 10th-grade subjects by category, with both English and Dzongkha translations. We left the questions exactly as they are, meaning that we didn't fix the minor grammatical errors in some of the English versions.

You are provided with a multiple-choice exam question written in English, including its answer choices. The question is generally well-constructed but may occasionally contain slight grammatical errors or awkward phrasing. Your task is to revise and polish the question to make it sound more natural and fluent.

The answer choices are given for context, but your response should not include them. Ensure that you address the entire question, not just a portion of it. If there is an equation or formula within the question, leave it unchanged. Here is the question that needs revision:

Figure 9: GPT-4 prompt for creating Grammar-corrected questions.

You are given a multiple-choice question, and your task is to determine what type of reasoning is necessary to solve it. Choose from the following options:

1. Factual Knowledge: The question relies on recalling basic facts, dates, events, or concepts.
2. Procedural and Application: The question requires applying a procedure, formula, or set of steps to reach the answer.
3. Reasoning: The question demands multistep reasoning or logical deduction to find the solution.
Here is the question for you to evaluate:

Figure 10: DZEN dataset categorized questions prompt.

You are provided with a multiple-choice question and its options in English or Dzongkha. Your task is to correctly answer the question. Follow these steps:

1. Think and reason step by step, explaining your thought process in either English or Dzongkha.
2. After reasoning, select the final answer and provide it only as one letter: ”a”, ”b”, ”c”, or ”d”.
3. Do not include the text of the option—just the letter of the answer.
4. There will always be one correct answer among the given options, so never respond with ”none of the above” or give multiple answers.
Here is the question for you to answer:

Figure 11: Proprietary models prompt for DZEN zero-shot benchmark.

You are provided with a multiple-choice question in either English or Dzongkha.
Your task is to solve the question step by step and then give the correct answer.

Format:
{Question 1}
{Reasoning and Explanation}
{Answer 1}
{Question 2}
{Reasoning and Explanation}
{Answer 2}

{Question}
Now, follow the same process for the given question.

Figure 12: Proprietary models prompt for DZEN Few-shot benchmark.

You are given a situation along with its possible reason or answer in Dzongkha.
Your task is to identify the correct reason or answer for the given situation.

For your convenience, an English translation is also provided. However, you must respond only in Dzongkha.
Explain your reasoning step by step in Dzongkha, and finally provide your answer.
Here is the question:

Figure 13: Zero-shot append experiment prompt.

Table 6: DZEN dataset question count by subjects and categories.

Subject	Category	Questions	Instances (%)
	12th Grade Subjects		
12th Bio I	Factual Knowledge	288	5.58%
	Procedural & Application	12	0.23%
	Reasoning	15	0.29%
12th Bio II	Factual Knowledge	297	5.75%
	Procedural & Application	8	0.16%
	Reasoning	28	0.54%
12th Chem I	Factual Knowledge	229	4.44%
	Procedural & Application	85	1.65%
	Reasoning	58	1.12%
12th Chem II	Factual Knowledge	185	3.59%
	Procedural & Application	145	2.81%
	Reasoning	64	1.24%
12th Phy I	Factual Knowledge	115	2.23%
	Procedural & Application	161	3.12%
	Reasoning	32	0.62%
12th Phy II	Factual Knowledge	168	3.25%
	Procedural & Application	143	2.77%
	Reasoning	27	0.52%
12th Math I	Factual Knowledge	13	0.25%
	Procedural & Application	368	7.13%
	Reasoning	20	0.39%
12th Math II	Factual Knowledge	24	0.46%
	Procedural & Application	327	6.34%
	Reasoning	45	0.87%
	10th Grade Subjects		
10th Bio	Factual Knowledge	308	5.97%
	Procedural & Application	21	0.41%
	Reasoning	27	0.52%
10th Phy	Factual Knowledge	178	3.45%
	Procedural & Application	119	2.31%
	Reasoning	27	0.52%
10th Math I	Factual Knowledge	45	0.87%
	Procedural & Application	267	5.17%
	Reasoning	73	1.41%
10th Math II	Factual Knowledge	24	0.46%
	Procedural & Application	316	6.12%
	Reasoning	58	1.12%
10th Chem	Factual Knowledge	268	5.19%
	Procedural & Application	91	1.76%
	Reasoning	35	0.68%
	8th Grade Subjects		
8th Math	Factual Knowledge	30	0.58%
	Procedural & Application	139	2.69%
	Reasoning	45	0.87%
8th Sci	Factual Knowledge	194	3.76%
	Procedural & Application	26	0.50%
	Reasoning	13	0.25%
Total	**All**	**5161**	**100.00%**

Table 7: DZEN zero-shot benchmark.

Language	Subject	GPT-4	GPT-3.5	Claude 2.1	LLaMA2 (13b)	LLaMA2 (7b)	Mistral 7b
English	12th Bio I	84.67	69.33	59.52	38.24	30.61	31.59
	12th Bio II	82.15	64.11	55.44	33.82	24.79	38.27
	12th Chem I	82.83	57.51	52.18	24.29	19.47	27.23
	12th Chem II	81.12	56.24	51.89	23.75	14.63	22.51
	12th Phy I	81.47	62.33	48.41	29.28	17.32	25.39
	12th Phy II	82.48	59.63	37.95	23.52	25.61	27.96
	12th Math I	85.79	59.27	58.12	10.37	6.35	11.38
	12th Math II	77.21	53.45	56.73	17.05	6.95	15.28
	10th Bio	79.95	65.03	51.91	35.02	25.17	36.68
	10th Phy	78.88	62.63	53.19	29.07	19.53	26.92
	10th Math I	86.72	61.31	48.11	13.35	12.33	12.84
	10th Math II	84.39	63.17	49.68	9.41	10.67	15.41
	10th Chem	86.78	62.59	56.97	28.83	22.24	28.58
	8th Math	85.27	70.24	56.23	26.34	21.19	21.67
	8th Sci	77.43	63.27	54.24	42.23	23.78	37.08
Dzongkha	12th Bio I	65.23	28.57	32.14	–	–	–
	12th Bio II	63.87	25.34	28.93	–	–	–
	12th Chem I	61.42	24.16	27.53	–	–	–
	12th Chem II	59.85	22.63	25.82	–	–	–
	12th Phy I	62.58	26.43	29.75	–	–	–
	12th Phy II	60.17	23.85	26.27	–	–	–
	12th Math I	58.35	21.53	24.86	–	–	–
	12th Math II	54.68	18.94	22.15	–	–	–
	10th Bio	61.73	25.67	29.27	–	–	–
	10th Phy	59.28	23.17	26.85	–	–	–
	10th Math I	57.46	20.83	23.57	–	–	–
	10th Math II	55.94	19.47	21.96	–	–	–
	10th Chem	60.35	24.37	27.64	–	–	–
	8th Math	63.57	27.28	30.17	–	–	–
	8th Sci	58.47	22.75	25.48	–	–	–

Table 8: DZEN 10th grade few-shot benchmark. Note that w/ denotes with and w/o denotes without CoT.

Language	Dataset	CoT	GPT 3.5		LLaMA2 (7b)		LLaMA2 (13b)	
			5-shot	3-shot	5-shot	3-shot	5-shot	3-shot
English	10th Bio	w/o	58.39	59.27	48.85	43.63	43.63	39.28
		w/	67.95	69.63	49.72	49.72	48.85	43.63
	10th Phy	w/o	56.67	61.02	37.52	39.28	29.72	27.98
		w/	66.24	70.58	40.15	38.41	38.41	43.63
	10th Math I	w/o	41.89	43.63	30.58	25.37	34.06	28.85
		w/	66.24	69.63	28.85	26.24	37.52	33.19
	10th Math II	w/o	46.24	37.52	21.89	21.89	40.15	42.76
		w/	62.76	58.39	29.72	27.98	25.37	30.58
	10th Chem	w/o	58.39	58.39	36.67	37.52	27.11	25.37
		w/	68.85	63.63	44.50	42.76	43.63	42.76
Dzongkha	10th Bio	w/o	28.14	27.42	–	–	–	–
		w/	31.12	28.89	–	–	–	–
	10th Phy	w/o	35.52	30.32	–	–	–	–
		w/	39.21	33.28	–	–	–	–
	10th Math I	w/o	22.94	27.42	–	–	–	–
		w/	29.65	35.52	–	–	–	–
	10th Math II	w/o	28.14	28.85	–	–	–	–
		w/	34.78	38.47	–	–	–	–
	10th Chem	w/o	35.52	35.52	–	–	–	–
		w/	34.78	40.68	–	–	–	–

Table 9: Big-Bench Hard zero-shot benchmark.

Dataset	English Only	Dzongkha Only	Translation (Premium)	Append	Translation (GPT)	Append
Causal Judgement	57.2	43.2	53.0		51.4	
Date Understanding	56.0	20.2	36.8		28.1	
Disambiguation QA	45.2	32.0	47.4		45.9	
Formal Fallacies	55.2	42.9	42.8		41.4	
Logical Deductions Five	35.2	17.3	15.1		16.6	
Logical Deductions Seven	30.8	13.1	18.2		13.4	
Logical Deductions Three	51.6	28.2	30.7		31.2	
Multistep Arithmetic	68.5	39.2	34.8		–	
Navigate	60.4	44.5	49.7		50.8	
Object Counting	83.6	27.8	34.9		37.4	
Penguin In A Table	61.0	20.8	29.1		29.1	
Reasoning About Colored Objects	42.4	19.2	25.9		23.0	
Temporal Sequences	37.6	18.9	18.2		17.0	
Web of Lies	52.8	17.0	39.0		38.4	

Physics

Factual Knowledge
Which one is the fundamental unit?
(a) Joule
(b) Newton
(c) Candela
(d) Pascal

གཅིངས་གྲུ་བའི་ཚད་གཞི་གང་ཡིན་རན།
(a) ཇུལ།
(b) ནི་ཏུ་ཏོན།
(c) ཀེན་རྡེ་ལ།
(d) པ་སཀཱལ།

Procedural & Application
The atmospheric pressure of a certain place is 93296 Pa. The density of kerosene is 800 kg/m^3, and the density of benzene is 980 kg/m^3. Which one of the following is correct?
(a) The height of the mercury column is 76 cm.
(b) The height of the water column is 9.52 m.
(c) The height of the kerosene column is 9.71 m.
(d) The height of the benzene column is 11.9 m.

གནས་གྲའི་གཤོག་སྟོན་གྱི་ཚད་རྟས་པ་དེ་ 93296 Pa ཡིན། ཀེ་རོ་སིན་གྱི་ཚད་རྟས་པ་དེ་ 800 kg/m^3 དང། བེན་ཟིན་གྱི་ཚད་རྟས་པ་དེ་ 980 kg/m^3 ཡིན། གཤས་གྱི་དཔེ་བརྗོད་དུང་གི་ནང་གི་གང་ཞེག་རིགས་ཡིན་རན།
(a) དཀྱལ་ཚུའི་སྐུ་རིམ་གྱི་མཐོ་ཚད་དེ་ 76 cm ཡིན།
(b) ཚུའི་སྐུ་རིམ་གྱི་མཐོ་ཚད་དེ་ 9.52 m ཡིན།
(c) ཀེ་རོ་སིན་གྱི་སྐུ་རིམ་གྱི་མཐོ་ཚད་དེ་ 9.71 m ཡིན།
(d) བེན་ཟིན་གྱི་སྐུ་རིམ་གྱི་མཐོ་ཚད་དེ་ 11.9 m ཡིན།

Reasoning
As someone goes up from the sea level:
i. The weight of the atmosphere increases.
ii. The density of air decreases.
iii. The pressure of air decreases.
Which one is correct?
(a) i and ii
(b) i and iii
(c) ii and iii
(d) i, ii, and iii

མཚོ་རིགས་ནས་མཐོ་སྨད་དུ་སོང་བའི་སྐབས་ལ་:
i. གནམ་གྲའི་གཤོག་སྟོན་གྱི་ཚད་རྟས་པ་རེས་འཕེལ་བ།
ii. གནམ་གྲའི་ཚད་རྟས་པ་རྒྱང་དྲང་འགྱོ་བ།
iii. གནམ་གྲའི་གཤོག་སྟོན་གྱི་ཚད་རྟས་པ་རྒྱང་དྲང་འགྱོ་བ།

གང་ཞེག་རེས་གཞི་ཡིན་རན།
(a) i དང་ ii
(b) i དང་ iii
(c) ii དང་ iii
(d) i, ii, དང་ iii

Figure 14: Physics sample questions for the 1oth grade in DZEN by category.

Chemistry

Factual Knowledge
In which of the following compounds is the latent valency of iron zero?
(a) $FeSO_4$
(b) $Fe(NO_3)_2$
(c) $Fe_2(SO_4)_3$
(d) $FeCO_3$

གང་ཞིག་གི་ནང་ལ་ལྷག་པ་རྣམས་ཀྱི་ཁས་ལེན་ལ་བཙོང་རྟགས་པ་ཀླད་ཀོར་ཡིན་ནམ།
(a) $FeSO_4$
(b) $Fe(NO_3)_2$
(c) $Fe_2(SO_4)_3$
(d) $FeCO_3$

Procedural & Application
A is a hydrocarbon with the formula C_nH_{2n+1}-CH=CH_2. What is the name of 'A' when n = 2?
(a) 1-Butene
(b) 2-Butene
(c) 3-Butene
(d) Butyne

A ནི་ཅའི་རྫི་ཀར་བླུན་ཐྲི་ཐུ་བའི་ཚད་གཞི་ C_nH_{2n+1}-CH=CH_2 ཡིན། n = 2 ཡིན་པའི་སྐབས་སུ་ 'A' ཡི་མིང་གང་ཡིན་ནམ།
(a) 1-བྷུ་ཏེན།
(b) 2-བྷུ་ཏེན།
(c) 3-བྷུ་ཏེན།
(d) བྷུ་ཏེན།

Reasoning
The proton numbers of P, Q, R, and X are 5, 9, 11, and 12, respectively. [Here, P, Q, R, X are not actual symbols of elements.] Which element has the largest atomic size?
(a) P
(b) Q
(c) R
(d) X

P, Q, R, དང་ X ཡི་རྫོ་ཏོན་ཐྲི་ཨང་ཀི་རིམ་པ་ 5, 9, 11, དང་ 12 ཡིན། [འདིར་ P, Q, R, X ནི་དངོས་སུ་རྩ་རྒས་ཀྱི་མཚོན་རྟགས་མིན།] གང་ཞིག་གི་ཨེ་ཏོམ་ཐྲི་ཚད་རྣམ་པ་རྩེ་མོན་ཡིན་ནམ།
(a) P
(b) Q
(c) R
(d) X

Figure 15: Chemistry sample questions for the 1oth grade in DZEN by category.

Biology

Factual Knowledge
Which blood group is called the universal blood donor?
(a) A
(b) B
(c) AB
(d) O

གང་ཞིག་གི་ཁྲག་གི་རིགས་ཀྱི་མིང་ལ་སྤྱི་མངའ་དཔོན་ཁྲག་ཞེས་པ་ཞེས་ཡིན་ནམ།
(a) A
(b) B
(c) AB
(d) O

Procedural & Application
In the formation of female gametophyte, four haploid cells are produced from a reproductive mother cell. The upper three cells degenerate, and the lower one divides. Which process is responsible for the formation of these four cells?
(a) Mitosis
(b) Meiosis
(c) Amitosis
(d) Binary fission

མོ་རྣམ་ཀྱི་སྡེ་གི་གླུབ་པའི་སྐབས་སུ་སྐྱེ་བ་སྤྱིའི་སྡེ་བ་ནས་བརྒྱ་སྟེ་གཞི་སྟེ་རྒྱུད་དུའི་ཁྲག་ཉེར་བ་བཟོ་བ་ཡིན། སྟེང་གི་སྡེ་བ་གསུམ་ནི་ཉམས་པ་དང་། འོག་གི་སྡེ་བ་གཅིག་ནི་ཕྱེ་བ་ཡིན། གང་ཞིག་གི་ལས་སྐུ་པ་དེ་བཞི་སྟེ་རྒྱུད་དུའི་ཁྲག་ཉེར་བ་བཟོ་བ་ཡིན་ནམ།
(a) མི་ཏོ་སིས།
(b) མེ་ཡོ་སིས།
(c) ཨ་མི་ཏོ་སིས།
(d) གཉིས་སྟེ་ཕྱེ་བ།

Reasoning
Grasshopper $\rightarrow$ $Martin \rightarrow Snake$
$Whatdoestheflowchartindicate?$
$(a)Strugglewiththeenvironment$
$(b)Interspeciesstruggle$
$(c)Intraspeciesstruggle$
$(d)Naturalselection$

$\rightarrow$ $\rightarrow$

(a)
(b)
(c)
(d)

Figure 16: Biology sample questions for the 10th Grade in DZEN by category.

Mathematics

Factual Knowledge
The centre of the circumscribing circle of what type of triangle is situated on the longest side of the triangle?
(a) Equilateral
(b) Acute-angled
(c) Obtuse-angled
(d) Right-angled

གང་ཞིག་ཅི་རིགས་ཀྱི་སྐུ་བཞིའི་ཚོད་ཀྱི་རྣ་སྐོར་བའི་སྐོར་དབྱིབས་ཀྱི་ཐོག་གས་ཀྱི་ཐོག་ལ་ཨོས་སུ་གནས་པ་ཡིན་ནས།
(a) སཁུམ་ཐོག་གས་ཀྱི་ཐོ།
(b) མཐོ་ཚད་ཀྱི་སྐུ་ཐཞི།
(c) དམའ་ཚད་ཀྱི་སྐུ་ཐཞི།
(d) གཡས་ཀྱི་སྐུ་ཐཞི།

Procedural & Application
If the length of a perpendicular on the chord is 3 cm from the centre of a circle with a radius of 5 cm, what is the length of that chord?
(a) 16 cm
(b) 8 cm
(c) 4 cm
(d) 2 cm

གལ་སྲིད་སྐོར་དབྱིབས་ཀྱི་ཐོག་གས་ཆེ་ཤོས་ནས་ཐོག་གས་ཀྱི་ཐོག་ལ་རྒྱུ་ལ་ཐུག་པའི་ཚད་དེ་ཚོད་ཅོད་ 3 cm ཡིན་པ་དང་། སྐོར་དབྱིབས་ཀྱི་ཐོག་གས་ཆེ་ཤོས་ཀྱི་ཚད་དེ་ཚོད་ཅོད་ 5 cm ཡིན་ན། དེའི་ཐོག་གས་ཀྱི་ཐོག་ལ་རྒྱུ་ཚད་དེ་ཚོད་ཅོད་ཀག་ཡིན་ནས།
(a) 16 cm
(b) 8 cm
(c) 4 cm
(d) 2 cm

Reasoning
If $x + \frac{1}{x} = 5$, then:
(i) $(x - \frac{1}{x})^2 = 21$
(ii) $x^2 - 5x + 1 = 0$
(iii) $x^3 + \frac{1}{x^3} = 25$

Which one is correct?
(a) i and ii
(b) ii and iii
(c) i and iii
(d) i, ii, and iii

གལ་ཏེ $x + \frac{1}{x} = 5$, དེ་ལས་:
(i) $(x - \frac{1}{x})^2 = 21$
(ii) $x^2 - 5x + 1 = 0$
(iii) $x^3 + \frac{1}{x^3} = 25$

གང་ཞིག་རྩོལ་གཞི་ཡིན་ནས།
(a) i དང་ ii
(b) i དང་ iii
(c) ii དང་ iii
(d) i, ii, དང་ iii

Figure 17: Mathematics sample questions for the 1oth grade in DZEN by category.