Small Shifts, Big Gains: Rethinking Creativity in the Age of Accountability

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ABSTRACT

Objectives. This study explored the impact of intentionally designed constraints on the creativity of Generation Z pre-service teachers (GZ-PSTs) enrolled in a public educator preparation program (EPP). Grounded in Stokes' (2009) Constraint-Based Model of Novelty (C-BMN), the research investigated whether input ("use what you got") and output ("this is what it looks like") constraints could enhance creative problem-solving, particularly in the context of captioning a visual prompt.

Materials and methods. A nonequivalent posttest-only quasi-experimental design was used with a convenience sample of 39 GZ-PSTs, randomly assigned to one of three conditions: input constraint, output constraint, or constraint-free (control). All participants completed the same creative task—captioning a cartoon image. Captions were evaluated using the validated NEW rubric (Henriksen et al., 2015), which measures novelty, effectiveness, wholeness, and total creativity score (TCS). Two trained faculty raters independently scored the responses. Kruskal-Wallis and Dunn's (1964) post hoc analyses were used to test differences between groups, and inter-rater reliability was confirmed via Cohen's kappa.

Results. Statistically significant differences were found across all creativity dimensions, with the constraint-free group scoring the lowest (TCS M = 5.54) and the output constraint group scoring highest (TCS M = 12.27). Effect sizes were moderate to large. These findings support the premise that designed constraints—when thoughtfully implemented—can scaffold creative thinking in pre-service teachers.

Conclusions. The study highlights the value of integrating constraint-based strategies in educator preparation, especially for Generation Z learners who have experienced highly structured, test-driven K–12 environments. Embedding such strategies may empower pre-service teachers to think creatively within standardized curricular frameworks.

Keyword: Generation Zpre-service teachers, creativity, designed constraints, educator preparation, C-BMN framework

INTRODUCTION

Standardized testing in the United States has significantly shaped classroom instruction, often narrowing the curriculum to focus on tested subjects and changing how teachers perceive education (Weick& Shaughnessy, 2024). This is particularly relevant for Generation Z pre-service teachers (GZ-PSTs)—individuals born between 1995 and 2010 (Fodor & Jaeckel, 2018)- and raised within highly structured K–12 environments—who are now entering educator preparation programs (EPPs) shaped by similar top-down expectation (Fraser &Hawly, 2023).These pre-service teachers must be prepared not only to traverse through content-rigid curriculm and high accountability standards but also be able to design engaging and differentiated lessons to meet their students' needs.While there is an abundance of anecdotal observations and general descriptions of Generation Z in popular media and educational literature, there remains a lack of empirical research specifically focused on their creative thinking skills within the context of pre-service teacher education (Nicholas & Arlene, 2020).

One promising approach to promoting creativity within such environments is the use of intentionally designed constraints, which structure the problem space in ways that foster originality rather than limit it (Stokes, 2009). Constraints can take many forms: input constraints, or "use what you got," which limit available tools or information; and output constraints, or "this is what it looks like," which limit the format or structure of the final product. Research findings suggest that when applied purposefully, such constraints can enhance creative performance by focusing attention, reducing decision fatigue, and fostering more divergent thinking (Roskes, 2015; Tromp & Baer, 2022).

While designed constraints have been studied in the context of business, engineering, and the arts, limited empirical research exists on their effects in teacher education, particularly among Generation Z learners. Given their background in standards-based schooling, GZ-PSTs may respond uniquely to constraint-based tasks. This study addresses that gap by examining how input and output constraints influence the creativity of GZ-PSTs in a specific task that does not require any prior creative talent, captioning a cartoon. Framed by the Constraint-Based Model of Novelty (C-BMN) (Stokes, 2009), this research investigates whether these structured limitations enhance or inhibit creative performance.

Statement of the Problem

Prior research has demonstrated that intentionally designed constraints can positively influence creativity and performance among Millennial populations, including pre-service teachers (Hinchman, 2022) and collegiate athletes (Hinchman et al., 2023). These studies provided evidence that structured limitations—such as input constraints ("use what you got") and output constraints ("this is what it looks like")—can serve as productive cognitive tools that foster innovation within defined boundaries. However, despite these promising findings, there remains a critical gap in the literature regarding how Generation Z pre-service teachers (GZ-PSTs) respond to constraint-based tasks.

Despite growing calls for creativity in education, educator preparation programs (EPPs) often operate within rigid curricular standards that mirror the structured environments in which Generation Z pre-service teachers (GZ-PSTs) were themselves educated (McLaughlin &Berlinghoff, 2022). These future educators are expected to foster creative thinking in their own classrooms, yet they have limited experience navigating or designing instruction under constraint-based conditions that promote creativity. The problem addressed in this study is the lack of empirical research on how constraint-based instructional strategies influence the creativity of GZ-PSTs, particularly in contexts where creative flexibility must coexist with highly structured curricula.

LITERATURE REVIEW

This study is grounded in Stokes' (2009) Constraint-Based Model of Creativity (C-BMN), which conceptualizes creativity not as the absence of limitation, but as the productive navigation of structured problem spaces. The framework consists of four interrelated constructs: (a) the creativity problem, (b) constraints, (c) variability, and (d) the problem space (Stokes, 2006, 2009). Any problem that requires creativity to resolve typically begins as an ill-structured one, meaning it lacks a linear or singular resolution pathway. The problem's resolution depends on the strategic usage of constraints, which serve to both block conventional pathways and activate novel solutions. Constraints guide the problem-solver to reframe the task, reinterpret resources, and renovate within imposed boundaries. Variability relates to assortment of possible outcomes that emerge within the constrained problem space, where higher variability is associated with more novel and original outputs (Stokes, 2006). The problem space represents the mental arena in which cognitive operations occur—its design, structure, and constraints influence the types of behaviors and ideas that can emerge. The C-BMN emphasizes that creative acts are not spontaneous or free-form but are shaped by how individuals perceive and navigate constraints in a bounded space (Stokes, 2001, 2006, 2014). In this study, the C-BMN guided both the design of the experimental tasks and the interpretation of how Generation Z pre-service teachers (GZ-PSTs) responded to input and output constraints in a structured captioning problem.

Recent research findings confirm that constraints can have both facilitative and inhibitory effects on creative performance, depending on their type, combination, and implementation context. A comprehensive meta-analysis by Damadzic et al. (2022) found that designed constraints generally enhance creative output,

particularly when they are moderately restrictive and well-aligned with task demands. Constraints help reduce cognitive overload by narrowing the problem space, thereby encouraging individuals to engage in deeper processing, explore non-obvious solutions, and avoid default or habitual responses (Hatchuel& Chen, 2017; Haught-Tromp, 2017). This supports prior work suggesting that input constraints (e.g., "use what you got") and output constraints (e.g., "this is what it looks like") can activate divergent thinking by limiting choices in ways that direct attention and stimulate novelty (Stokes, 2013; Rosso, 2014). Constraints do not uniformly benefit all individuals or situations. The interaction of constraint types—whether imposed, self-imposed, or resource-based—plays a key role in shaping creative problem-solving (Cromwell, 2023).

Generation Z pre-service teachers (GZ-PSTs) have been shaped by a cultural and educational landscape marked by heightened fear, stress, and standardization (Adrian &Sahrani, 2021). Their K–12 educational experiences often emphasized rote memorization and performance on standardized assessments, which can suppress opportunities for synthesizing knowledge and applying it in novel contexts (Gölöglu Demir&Kaplan Keles, 2021). As a result, educator preparation programs (EPPs) face unique challenges in cultivating creativity among GZ-PSTs, who often require supportive learning environments that address both their cognitive and social-emotional needs (Erenli, 2016; Hosek & Titsworth, 2016; Miller & Mills, 2019).

The purpose of this quantitative, nonequivalent posttest-only quasi-experimental study was to examine the effects of intentionally designed constraints—input or output—on the creativity of Generation Z pre-service teachers (GZ-PST) enrolled in a US southwestern educator preparation program. A convenience sample of 39 students, all over the age of 18 and participating under exempt IRB approval, were assigned to one of three groups: an input constraint group (ICG), an output constraint group (OCG), or a control group with no constraint (CCG). Participants completed a creative captioning task for the same AI-generated cartoon image. Creativity was assessed using the NEW rubric (Henriksen et al., 2015), which evaluates three dimensions of creative performance: *novelty*, *effectiveness*, and *wholeness*. A Total Creativity Score (TCS) was also calculated by summing the three domain scores. This study aimed to determine whether the type of constraint imposed produced statistically significant differences in creativity outcomes among GZ-PST, addressing a critical gap in the literature on specific constraint-types influence creative outputs of this educator cohort.

This study tasked 39 GZ-PST to caption the same AI-generated cartoon (Appendix A). 13 GZ-ST captioned the cartoon using an input constraint (ICG), 13 GZ -ST using an output constraint (OCG), and 13 GZ -ST without a constraint (CCG).

Research Questions and Hypotheses

To address the study's central problem and purpose, the following overarching research question was posed: How do intentionally designed constraints influence the creative captioning performance of Generation Z pre-service teachers (GZ-PST)? This guiding question was further explored through three specific research questions focused on comparing creativity outcomes—measured by the NEW rubric domains of *novelty*, *effectiveness*, and *wholeness*, as well as the composite Total Creativity Score (TCS)—across participants assigned to input-constraint, output-constraint, and control conditions.

RQ_1: Is there a statistically significant difference between the means of the Total Creativity Scores (TCS) among the input-constraint, output-constraint, and control groups in caption creativity produced by GZ-PST?

H_{O1}: Nostatistically significant difference exists in in the mean Total Creativity Scores (TCS) among the three groups: input-constraint, output-constraint, and control.

H_{01}: $\mu ICG = \mu OCG = \mu CCG$

H_{A1}: A statistically significant difference exists in in the mean Total Creativity Scores (TCS) among the three groups: input-constraint, output-constraint, and control.

H_{A1}: $\mu ICG \neq \mu OCG$ or $\mu ICG \neq \mu CCG$ or $\mu OCG \neq \mu CCG$

RQ_2: Is there a statistically significant difference in creativity—measured by novelty, effectiveness, wholeness, and the Total Creativity Score (TCS)—between the Input Constraint Group (ICG) and the Control Group (CCG)?

H_{O2}: There are no statistically significant differences in the mean scores for *novelty*, *effectiveness*, *wholeness*, or the Total Creativity Score (TCS) between the Input Constraint Group and the Control Group.

H_{02}: μICG, novelty=μCCG, novelty and μICG, effectiveness=μCCG, effectiveness and μICG, wholeness =μCCG, wholeness and μICG, TCS=μCCG, TCS

H_{A2}: There is a statistically significant difference in at least one of the mean scores (*novelty*, *effectiveness*, *wholeness*, or TCS*) between the Input Constraint Group and the Control Group.

H_{A2}: μICG≠μCCG *for at least one of the creativity dimensions or the TCS*

RQ_3: Is there a statistically significant difference in creativity—measured by novelty, effectiveness, wholeness, and the Total Creativity Score (TCS)—between the Output Constraint Group (OCG) and the Control Group (CCG)?

H_{O3}: There are no statistically significant differences in the mean scores for *novelty*, *effectiveness*, *wholeness*, or the Total Creativity Score (TCS) between the Output Constraint Group and the Control Grop.

H_{03}: μOCG, novelty=μCCG, novelty and μOCG, effectiveness=μCCG, effectiveness and μOCG, wholeness =μCCG, wholeness and μOCG, TCS=μCCG, TCS

H_{A3}: There is a statistically significant difference in at least one of the mean scores (*novelty*, *effectiveness*, *wholeness*, or TCS*) between the Output Constraint Group and the Control Group..

H_{A3}: μOCG≠μCCG *for at least one of the creativity dimensions or the TCS*

METHOD

This study employed a nonequivalent posttest-only quasi-experimental design with a comparison group (NPQCG)to investigate the effects of intentionally designed constraints on the creative performance of Generation Z pre-service teachers (GZ-PST). This design was selected due to the natural classroom grouping structure within a US southwestern Educator Preparation Program (EPP), which precluded random assignment while still enabling comparative analysis across experimental and control conditions (Leedy et al., 2019). In this design, two treatment groups—the Input Constraint Group (ICG) and the Output Constraint Group (OCG)—were compared to a Constraint-Free Control Group (CCG). Each group included 13 participants, resulting in a total sample size of 39 GZ-PSTs.

This NPQCG design allowed for the examination of treatment effects post-intervention without a pretest. As all participants were drawn from intact course sections within the same EPP and received similar academic instruction and program experiences, this quasi-experimental approach provided practical internal validity despite the lack of random assignment.

Participants

The participants were 39 Generation Z pre-service teachers (GZ-PSTs) enrolled in a public university educator preparation program (EPP) in the US southwest. All participants were publicly educated within the region and were accepted into the EPP under consistent admission criteria, which included a minimum cumulative grade point average (GPA) of 3.0.

To ensure relative homogeneity across groups, all participants completed the same sequence of coursework, participated in gradual-release style field experiences, and were taught by the same faculty members. This

uniform academic and clinical background helped to reduce potential variability in instructional exposure and cognitive development that might influence creativity outcomes.

All participants were 18 years of age or older and voluntarily consented to participate under an exempt protocol approved by the university's Institutional Review Board. Participants were assigned to one of three conditions: the Input Constraint Group (ICG; *n* = 13), the Output Constraint Group (OCG; *n* = 13), or the Constraint-Free Control Group (CCG; *n* = 13).The sample was predominantly female (66.7%), with all participants reporting a public-school background. The majority identified as White (87.2%) and unmarried (92.3%). Participants represented a range of certification areas, with the largest proportion pursuing elementary certification (43.6%), followed by high school Social Studies (17.9%), and various content-specific and specialty areas across grade bands (see Table 1).

Table 1 Demographic Characteristics of Participants

Variable	Category	n	%
Gender	Male	13	33.3
	Female	26	66.7
Educational Experience	Public School	39	100
Race	African America	3	7.7
	White	34	87.2
	Other	2	5.1
Marital Status	Married	3	7.7
	Unmarried	36	92.3
Certification Area	Elementary	17	43.6
	Middle School Math	1	2.6
	Middle School Science	1	2.6
	High School Math	2	5.1
	High School Science	1	2.6
	High School Social Studies	7	17.9
	Physical Education	4	10.3
	Art/Music/Theatre	6	15.4

Note. Note, n= 39; Percentages are rounded to one decimal place.

Data Source

Two primary data sources were used in this study: a captionless cartoon image and a standardized creativity assessment rubric. The cartoon, adapted from a *New Yorker*-style format, served as the stimulus for a captioning task designed to elicit creative responses from participants. Creativity was evaluated using

the NEW rubric (Henriksen et al., 2015), which assessed each caption across three domains—*novelty*, *effectiveness*, and *wholeness*—as well as a composite Total Creativity Score (TCS).

A brief demographic questionnaire was also administered to collect descriptive data on participants' gender, educational background, ethnicity, marital status, and certification area. The survey was accompanied by clear written instructions to minimize misinterpretation and enhance response validity. Though surveys and rubrics have known limitations related to subjectivity and consistency, these concerns were mitigated by training two independent raters and establishing inter-rater reliability procedures. The alignment between the rubric and the constructs being measured was also verified through content validity review.

These data sources were essential in addressing the study's research questions and hypotheses, enabling a quantitative analysis of how intentionally designed constraints influenced creative performance among GZ-PSTs.

Instrumentation

The captions generated by the participants were evaluated using the NEW Rubric (Henriksen et al., 2015). The rubric measures creative products across three subdimensions: novelty, effectiveness, and wholeness, using a 5-point Likert-type scale (1 = minimal, 5 = exceptional). These three subdimension scores were summed to produce a Total Creativity Score (TCS) ranging from 3 to 15.

This study adapted the original rubric to assess cartoon captions instead of full projects as intended by the original authors. The structure and scoring anchors remained unchained, the descriptors were slightly modified to reflect the short-form caption responses. In this study, novelty refers to the originality and uniqueness of the caption; effectiveness assess is clarity and communicative strength; and wholeness reflects its alignment contextually with the image presented.

Two trained raters independently scored each caption using the rubric. Inter-rater reliability and content validity procedures are described in the following section.

Validity and Reliability

Two trained university faculty members independently evaluated each caption using the adapted NEW Creativity Rubric (Henriksen et al., 2015).To establish the alignment between the rubric criteria and the intended constructs of creativity, a content validity ratio (CVR) was calculated following the guidelines of Ayre and Scally (2014). Three subject matter experts reviewed the rubric's alignment with the constructs of novelty, effectiveness, and wholeness. The resulting CVR was 1.00, which exceeds the recommended threshold of .99, indicating strong content validity.

Inter-rater reliability was assessed using Cohen's kappa for each scoring dimension. The results indicated substantial to almost perfect agreement: *novelty* ($\kappa = .798$), *effectiveness* ($\kappa = .900$), *wholeness* ($\kappa = .837$), and *total creativity score (TCS)* ($\kappa = .704$). These values suggest a high level of consistency between raters, supporting the reliability of the scoring process (Landis & Koch, 1977).

Procedure

Three problem space packets were prepared corresponding to the study conditions: Input Constraint Group (ICG), Output Constraint Group (OCG), and Constraint-Free Control Group (CCG). Each packet included (a) an informed consent form, (b) a demographic questionnaire, (c) group-specific instructions for captioning, and (d) the visual problem space—a captionless cartoon image modeled in the style of *The New Yorker* (see Appendix A).

Participants were recruited from professional educational courses during the fall term at the US southwest public university EPP during a four-day window. The researcher visited six courses during that window across the morning and window to administer the materials in person. The data collection procedure was standardized across all sessions.

At the beginning of each session, participants reviewed and signed the informed consent form. They were then provided with a sealed, opaque envelope containing one of the pre-randomized problem-space packets. Packet distribution was randomized using a sequential number generator to minimize researcher bias in group assignment. Participants were unaware of which constraint group they were assigned to until opening the packet.

After completing the demographic form, participants were instructed to review the cartoon and compose a caption according to the instructions specific to their assigned group. This task required approximately 15 minutes. Upon completion, participants placed all materials—the informed consent form, demographic questionnaire, and completed caption—back into the provided nontransparent envelope and returned it to the researcher.

All 39 completed packets were then reviewed by two independent faculty raters, who assessed each caption using the adapted NEW Rubric (Henriksen et al., 2015). Each caption was evaluated for *novelty*, *effectiveness*, and *wholeness*, with scores combined to yield a Total Creativity Score (TCS). Inter-rater reliability and content validity procedures were implemented prior to analysis to ensure scoring consistency and construct alignment (Ayre & Scally, 2014).

Data Analysis

The data wereanalyzed using the Statistical Package for Social Sciences (IBM SPSS Statistics, 2024). Prior to analysis, data were screened for normality and outliers. Due to the presence of significant outliers and non-normal distribution across several variables, a nonparametric Kruskal–Wallis H test was used to assess differences among the three groups: Input Constraint Group (ICG), Output Constraint Group (OCG), and Constraint-Free Control Group (CCG).

RESULTS

To address the first research question, a Kruskal–Wallis H test was used to compare creativity scores across the three constraint conditions: Input Constraint, Output Constraint, and Constraint-Free Control. Statistically significant differences were found across all creativity dimensions.

For novelty, the test revealed a significant difference among the groups, $\chi^2(2) = 18.532$, $p < .001$. A similar pattern was found for effectiveness, $\chi^2(2) = 14.315$, $p < .001$, and wholeness, $\chi^2(2) = 19.434$, $p < .001$. The groups also differed significantly on Total Creativity Score (TCS), $\chi^2(2) = 18.093$, $p < .001$.

These results indicate that the type of constraint applied had a significant effect on the creative captioning abilities of Generation Z pre-service teachers across all measured domains, rejecting Null Hypothesis 1. Table 2 reports the mean creativity scores in for each constraint group.

Table 2 Creativity Scores by Constraint Group

Constraint Group	n	Mean Novelty	Mean Effectiveness	Mean Wholeness	Mean TCS
ICG	13	3.846	3.654	3.615	11.115
OCG	13	3.731	4.308	4.231	12.269
CCG	13	1.577	1.1644	1.1065	5.538

Post hoc Dunn's (1964) pairwise comparisons were conducted to address Research Questions 2 and 3. Results revealed statistically significant differences in Total Creativity Scores (TCS) between both the Input Constraint Group and the Constraint-Free Control Group, $\chi^2(2) = 14.577$, $p < .001$, and the Output Constraint Group and the Constraint-Free Control Group, $\chi^2(2) = 17.615$, $p < .001$ (Table 6) . Significant differences were also observed across all subcomponents of creativity: novelty (Table 3), effectiveness (Table 4), and wholeness

(Table 5) . As such, the null hypotheses for both Research Questions 2 and 3 were rejected. These findings indicate that both input and output constraints significantly improved the creative performance of Generation Z pre-service teachers compared to no constraints.

Effect size calculations using Cohen's η^2 further support these findings, with large effects observed for both groups: the Output Constraint Group showed effect sizes of .427 (novelty), .399 (effectiveness), .534 (wholeness), and .484 (TCS), while the Intput Constraint Group showed comparably large effects across the same domains. These results suggest that designed constraints meaningfully enhance creativity in this population.

Table 3 Dunn's Pairwise Comparison Post Hoc Test for Novelty

Samples	Dunn's Test Statistic	Std. Error	Std. Test Statistic	Sig.
ICG-CCG	16.077	4.381	3.670	<.001
OCG-CCG	16.577	4.381	3.784	<.001
ICG-OCG	-.500	4.381	-.114	.909

Table 4 Dunn's Pairwise Comparison Post Hoc Test for Effectiveness

Samples	Dunn's Test Statistic	Std. Error	Std. Test Statistic	Sig.
ICG-CCG	10.269	4.349	2.361	.018
OCG-CCG	16.269	4.349	3.741	<.001
ICG-OCG	-6.000	4.349	-1.380	.168

Table 5 Dunn's Pairwise Comparison Post Hoc Test for Wholeness

Samples	Dunn's Test Statistic	Std. Error	Std. Test Statistic	Sig.
ICG-CCG	13.808	4.384	3.149	.005
OCG-CCG	18.615	4.384	4.246	<.001
ICG-OCG	-4.808	4.384	-1.097	.818

Table 6 Dunn's Pairwise Comparison Post Hoc Test for Total Creativity (TCS)

Samples	Dunn's Test Statistic	Std. Error	Std. Test Statistic	Sig.
ICG-CCG	14.555	4.428	3.292	<.001
OCG-CCG	16.577	4.428	3.979	<.001
ICG-OCG	-.500	4.428	-.686	.493

DISCUSSION OF THE RESULTS

The purpose of this study was to examine the effects of intentionally designed constraints—specifically input and output constraints—on the creative performance of Generation Z pre-service teachers (GZ-PSTs). Guided by the Constraint-Based Model of Creativity (C-BMN) (Stokes, 2009), this study sought to determine how structured limitations affect creativity in a population of future educators raised in standardized, public education systems. All participants were publicly educated and enrolled in a teacher preparation program with

a common curricular pathway, offering a highly relevant context for examining how structured tasks might promote creativity in a generation often critiqued for risk-aversion and preference for guided learning.

Statistically significant differences were found between both constraint groups and the constraint-free control group across all measured dimensions of creativity—novelty, effectiveness, wholeness, and Total Creativity Score (TCS). These results offer strong support for the underlying hypotheses and reinforce prior research on the positive impact of designed constraints in creative performance (Hinchman, 2022; Hinchman et al., 2023). The control group consistently scored lowest on each sub-component, highlighting a critical concern about the absence of constraints. When no constraints were applied, GZ-PSTS produced a significantly less creative caption. These findings reveal that GZ learners may struggle with open-ended prompts or unstructured tasks but may thrive under designed conditions that guide them toward completion.

This is consistent with Roskes' (2015) work on motivation schemas, which suggests that success-driven individuals often benefit from structured environments. Both input and output constraints may provide GZ-PSTs with the scaffolding needed to organize their thinking and activate divergent ideas within a focused space. The findings of the present study also align with Tan et al. (2023), who demonstrated that targeted instruction enhances critical and creative thinking in learners, particularly in online or self-regulated settings. In this case, designed constraints acted as a form of targeted cognitive structure that amplified the creative engagement of participants.

This study contributes to the growing body of research on how Generation Z pre-service teachers—especially those educated in highly structured public-school systems—can cultivate creativity within similarly structured educational environments. The results both validate the C-BMN overall usage but also emphasizes that GZ-PSTS may require specific conditions and limitations (like designed constraints) to maximize their creative potential. The very low creativity scores in the absence of such supports underscore the risks of assuming that creativity will emerge naturally in teacher preparation programs without instructional design strategies that incorporate constraint.

This work adds to a growing consensus among scholars that creativity can flourish under conditions of structured uncertainty, particularly when learners are taught how to identify and work within constraints (Tromp & Baer, 2022).In line with Taylor (2019), who explored the deliberate teaching of creativity in higher education, this study suggests that constraint-based tasks can be taught as a strategic pedagogical method—particularly for populations trained under rigid curricula. These findings advocate for the integration of constraint-based instruction into educator preparation programs to better support creativity development in novice teachers, especially as they transition into classrooms governed by highly structured standards and assessments.

Implications

The findings of this study hold significant implications for educator preparation programs (EPPs) seeking to foster creativity in Generation Z pre-service teachers, particularly those who have been educated in traditional, standards-based public-school systems. The consistently low creativity scores among participants in the constraint-free group underscore a crucial insight: creativity does not automatically emerge in the absence of structure. Rather, intentionally designed constraints—whether encouraging students to "use what you got" (input constraints) or specifying "this is what it looks like" (output constraints)—serve as productive cognitive scaffolds that help preservice teachers access deeper levels of originality, clarity, and contextual integration in problem-solving tasks.

Given how structured the K-12 learning environment can be with prescribed curricula and strict regulated observation cycles, it is essential that pre-service teachers are equipped with skills to innovate from within. One implication of this study is the importance of explicitly training pre-service teachers to recognize, apply, and design constraint-based strategies to maximize creative potential within structured environments. Learning how to think inside the curricular box through constraints, pre-service teachers can redesign existing lesson limitations to develop imaginative new learning experience for their future students.

Educator preparation programs should consider embedding constraint-based creativity training into professional courses, fieldwork reflections, lesson design, and instructional planning modules. For example, pre-service teachers could be taught to design tasks with intentional output limits (e.g., word count, media type, fixed usage) or input constraints (e.g., predefined vocabulary, mandatory resources, or fixed thematic lenses). Such strategies can be directly applied to teaching highly structured curricula, enabling pre-service teachers to move from procedural compliance to creative transformation within rigid systems.

Future Research

Building on the findings of this study, future research should explore the intersection of cognitive load theory and designed constraints in higher education learning environments. While the current results support the use of constraints to enhance creativity among Generation Z pre-service teachers, it remains unclear how these constraints interact with learners' cognitive processing capacities. Investigating how different types of constraints (e.g., input vs. output) affect working memory, task complexity, and mental effort could provide valuable insight into optimizing instructional design in teacher education. This line of research may also clarify which constraint formats best support deep learning and creativity without overwhelming learners, particularly in high-stakes or content-dense coursework. Such work would further refine the application of constraint-based pedagogy in preparing future educators for innovation within structured curricular systems.

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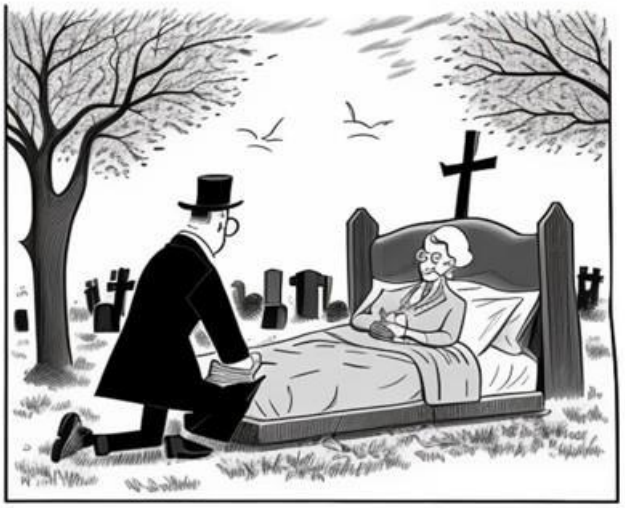
APPENDIX A: Caption Problem Spaces

OCG Problem Space

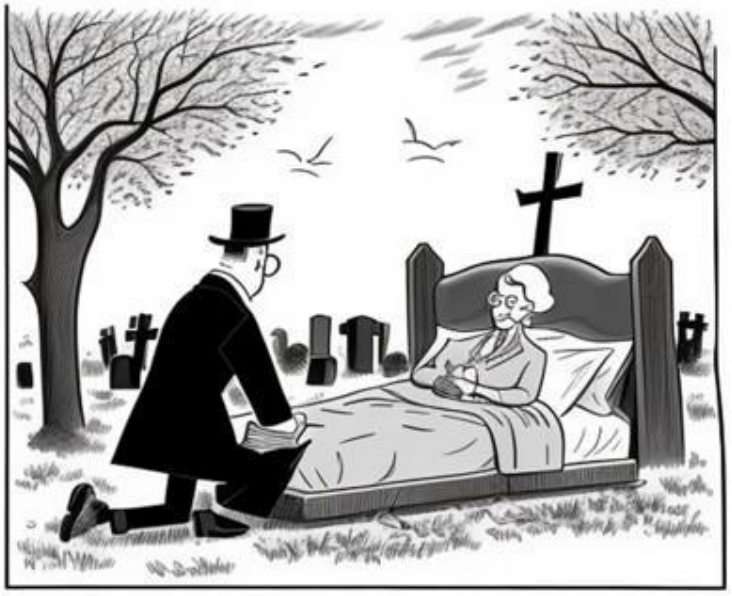
Provide an original caption to the following cartoon in **exactly seven** words. You can use any words that you wish to caption this cartoon.



Word #1 Word #2 Word #3 Word #4 Word #5 Word #6 Word #7

CCG Problem Space

Provide an original caption to the following cartoon.



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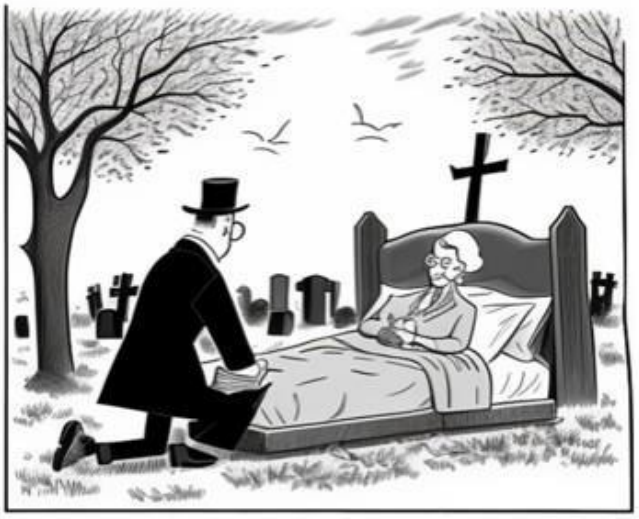
ICG Problem Space

Provide an original caption to the following cartoon. You will need to use at least one concrete noun from the left column and one concrete verb from the right column. Please note that you are allowed to modify the words to meet the needs of your caption (e.g. change tense).

Noun List:

1. Cancer
2. Elevator
3. Hurricane
4. Jacket
5. Kool-Aid
6. Murder
7. Nail
8. Screw
9. Shirt
10. Stairway
11. Sunshine
12. Tango
13. Titanic
14. Window
15. Wrench



Verb List:

1. Answer
2. Ask
3. Cry
4. Demand
5. Inquire
6. Interrupt
7. Mutter
8. Observe
9. Reason
10. Rejoin
11. Remark
12. Repeat
13. Reply
14. Return
15. Suggest