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Quantum Teaching Using TANDUR Syntax: A Complete Approach to Enhancing Cognitive, Affective, and Psychomotor Skills in Elementary Civic Education

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ABSTRACT

Purpose of the study: This study aims to analyze the effectiveness of TANDUR-based Quantum Teaching in improving student learning outcomes in the cognitive, affective, and psychomotor domains in Pancasila and Citizenship Education (PPKn) at the elementary school level.

Methodology: This research used a quantitative approach with a quasi-experimental nonequivalent control group design. The instruments used include a written test, learning motivation questionnaire, and performance observation sheet. The sample consisted of 42 fifth-grade students divided into experimental and control groups.

Main Findings: Students taught using the Quantum Teaching model scored higher in cognitive (78.12), affective (3.29), and psychomotor (80.10) domains than those in the control group. Statistical analysis showed significant differences ($p < 0.05$), with a dominant increase in learning motivation and social skills.

Novelty/Originality of this study: This study presents the comprehensive application of TANDUR-based Quantum Teaching in citizenship education to foster character development through cultural diversity. It contributes a holistic, engaging, and contextual learning model aligned with the principles of the Independent Curriculum.

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1. INTRODUCTION

Pancasila and Citizenship Education (PPKn) in elementary schools play a crucial role in shaping students into citizens who not only understand national values intellectually but also demonstrate attitudes and skills as active, reflective, and responsible citizens [1]-[3]. In a global context, elementary-level civic education emphasizes developing civic competencies, including social literacy, intercultural empathy, and collective responsibility for democratic life [4]-[7]. However, the reality of implementing PPKn learning in various elementary schools, especially in Indonesia, still shows the dominance of traditional approaches that are lecture-focused, one-way, and have not effectively addressed the affective and psychomotor domains.

Field observations at SDN Trans Pendingan reveal a significant learning gap, specifically low student engagement, weak motivation to learn, and learning outcomes that consistently fall below the Minimum Competency Criteria (KKM). This gap highlights a fundamental mismatch between the ideal goals of the curriculum, which focus on active, reflective, and value-based learning, and the current classroom reality, which

tends to be passive and monotonous. It also shows that a learning strategy focused solely on information transfer is no longer enough to meet the needs of 21st-century education, which demands full engagement of students cognitively, affectively, and psychomotorically [8]-[10].

To bridge this gap, a new pedagogical model is needed that promotes learning as an integrated and empowering process across domains. Quantum Teaching, with the syntax of TANDUR (Grow, Natural, Name, Demonstrate, Repeat, Celebrate), is one of the learning alternatives considered capable of addressing these challenges [11]-[14]. This approach not only prioritizes active and engaging learning but also creates an empowering, emotionally meaningful learning environment, fostering students' social engagement [15], [16]. Each stage in the TANDUR syntax is designed to activate the linkage between students' cognitive and affective processes, build interest, facilitate conceptual understanding, and provide space for performance and appreciation. Several studies have demonstrated the effectiveness of Quantum Teaching in enhancing student learning motivation and improving learning outcomes across various subjects [17]-[21]. However, studies that specifically test the application of Quantum Teaching in PPKn learning at the elementary school level, particularly in integrating cognitive, affective, and psychomotor aspects, are still very limited.

This research becomes urgent considering the unique character of PPKn, which demands not only the mastery of knowledge but also the internalization of values and the habituation of civic behavior through active participation. Based on this background, this research is important to be carried out as an effort to present a PPKn learning model that is more contextual, participatory, and oriented towards character strengthening. The novelty of this research lies in the integration of the TANDUR syntax into PPKn learning materials on social and cultural diversity in Grade V, with a holistic evaluation of learning outcomes across three domains: cognitive, affective, and psychomotor. The purpose of this study is to analyze the influence of the Quantum Teaching method on students' cognitive learning outcomes, assess the increase in affective aspects, including students' motivation and emotional involvement, and evaluate its impact on the development of social skills and students' active participation in PPKn learning.

In line with this, the study also formulates three main questions: (1) Is there a significant difference in cognitive learning outcomes between students who follow Quantum Teaching and those who follow conventional learning? (2) How does Quantum Teaching affect students' learning motivation and affective involvement in PPKn learning? and (3) To what extent does Quantum Teaching have an impact on the development of students' psychomotor skills in the context of PPKn learning?

The findings of this research are expected to contribute theoretically to the refinement of the Quantum Teaching model in civic education and provide practical implications for designing learning strategies that are aligned with the principles of the Merdeka Curriculum.

2. RESEARCH METHOD

This study uses a quantitative approach with a quasi-experimental design type, the Nonequivalent Control Group Design [22], [23]. This design was selected because the researcher could not randomly assign subjects to groups. Yet, it was still possible to administer different learning treatments and compare the resulting outcomes between the experimental and control groups. The design structure is illustrated as follows, based on 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O_1	Quantum Teaching	O_2
Control	O_3	Conventional Learning	O_4

The population of this study comprised all fifth-grade students from elementary schools in Cluster III of Muara Lakitan District, Musi Rawas Regency. The sample was selected using a convenience sampling technique, which involves selecting subjects based on accessibility and practical considerations [24]-[26]. Two schools were chosen as research sites: Elementary School Anyar, with 25 students as the experimental group, and Elementary School Trans Pendingan, with 17 students as the control group, resulting in a total sample of 42 students.

The research instruments were developed to assess three key domains of learning: cognitive, affective, and psychomotor. The cognitive domain was measured using a learning outcome test comprising 25 multiple-choice questions, which were constructed based on PPKn competency indicators related to socio-cultural diversity. The items were adapted from the official curriculum and relevant evaluation frameworks [27], and their content validity was reviewed and confirmed by three subject matter experts. The affective domain was assessed using a learning motivation questionnaire grounded in the ARCS Motivation Model (Attention, Relevance, Confidence, Satisfaction) [28], which was contextually modified for civic education learning. This questionnaire consisted of 20 items presented in a 5-point Likert scale format. Meanwhile, the psychomotor domain was evaluated using an observation sheet designed to capture students' performance in executing group

projects, delivering presentations, demonstrating cooperation, and participating actively in class. This instrument employed a 4-point rating scale to appraise students' task execution and civic behavior during learning activities.

Table 2. Instrument Grid for Data Collection

Domain	Indicator	Instrument Type	Number of Items
Cognitive	Understanding of socio-cultural diversity	Multiple-choice test	25
Affective	Motivation, interest, emotional involvement	Likert-scale questionnaire	20
Psychomotor	Participation, cooperation, project execution	Observation checklist	10

All instruments underwent content validation by civic education experts and were pilot-tested to ensure clarity and functionality. Reliability tests using Cronbach's Alpha yielded coefficients of 0.891 (cognitive), 0.874 (affective), and 0.902 (psychomotor), indicating high internal consistency. Data collection was carried out in several stages. Pretests and posttests were administered to both groups to measure cognitive development. The motivation questionnaire was administered after the intervention, while psychomotor performance was observed continuously during the implementation of group project tasks over two weeks.

The data analysis involved both descriptive and inferential statistics. Descriptive analysis included calculating means, standard deviations, and score distributions. Inferential analysis began with testing the assumption of normality using the Shapiro–Wilk test and homogeneity with Levene's test. Independent samples t-tests compared the mean scores between the experimental and control groups across the three learning domains. Statistical analyses were conducted using SPSS version 26. To interpret learning achievement, the score categories were defined as follows Table 3.

Table 3. PPKn Learning Outcomes Category

Score Range	Category
86 – 100	Excellent
71 – 85	Good
56 – 70	Enough
≤ 55	Less

The total sample size of 42 students (25 experimental, 17 control) was evaluated for statistical power using standard power analysis assumptions. According to G*Power software, for a two-tailed independent t-test, assuming a medium effect size (Cohen's $d = 0.5$), $\alpha = 0.05$, and power $(1 - \beta) = 0.80$, the necessary sample size is 34 participants. Therefore, the sample size in this study exceeds the minimum requirement, ensuring adequate statistical power to detect significant treatment effects.

3. RESULTS AND DISCUSSION

This study was carried out in three main phases: administering the pretest, implementing the treatment using the Quantum Teaching model with TANDUR syntax, and conducting the posttest. Data were gathered through cognitive learning outcome tests and learning motivation questionnaires. Instrument validation involved using Pearson's r for the cognitive and affective domains, and inter-rater reliability was assessed with Cohen's Kappa coefficient for the psychomotor domain, demonstrating that all instruments met the necessary standards of validity and reliability. A summary of the descriptive statistics for the pretest, posttest, and learning motivation scores is provided in Table 4.

Table 4. Descriptive Statistics of Learning Outcomes and Motivation

Group	Pretest	Posttest	Motivation	Motivational Elementary School	Min	Max
Experiment	67.05	76.35	3.29	0.32	2.72	4.00
Control	67.24	70.17	2.71	0.37	2.06	3.45

The experimental group showed higher posttest and motivation scores than the control group. This indicates that the TANDUR syntax in Quantum Teaching can enhance not only conceptual understanding but also emotional involvement and student enthusiasm, as suggested [29]-[32]. Supporting this, Table 5 and Figure 1 display the distribution of motivation categories.

Table 5. Distribution of Learning Motivation Categories

Category	Experiment	Control
Very High	10	3
Tall	15	9
Keeping	2	15
Low	0	0

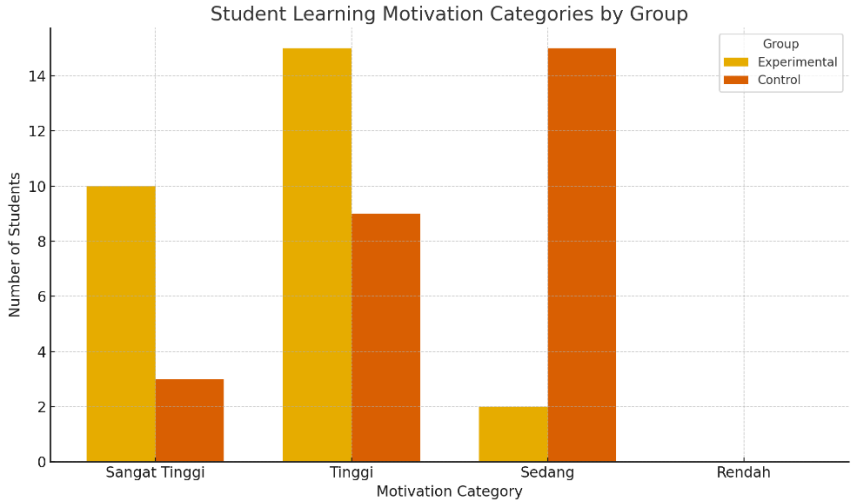

Figure 1. Student Learning Motivation Categories

The motivational profile shifted toward the upper categories in the experimental group, demonstrating that structured, emotionally engaging instruction fosters better affective outcomes. These results align with previous findings [33]-[36], which showed that Quantum Teaching promotes student interest and motivation by creating a learning atmosphere that is joyful, contextual, and connected to students' experiences. Instrument reliability testing further confirmed the internal consistency of the instruments used. Table 6 summarizes the results of the validity and reliability testing.

The results of the instrument test showed that the measuring instrument used was valid and reliable. The Pearson validity test showed a significant and strong correlation, while the reliability test with Cohen's Kappa showed inter-rater consistency in the category was very high, as summarized in Table 6.

Table 6. Instrument Validity and Reliability Test Results

Test	Value	Interpretation
Validity (Pearson)	$r = 0.763$, $p = 0.000$	Significant and powerful
Reliability (Kappa)	$\kappa = 0.877$	Very High.

Before hypothesis testing, normality and homogeneity tests were conducted. Shapiro–Wilk and Levene's Test showed $p > 0.05$, indicating that the data met assumptions for parametric testing.

Prerequisite tests are carried out before hypothesis tests. The normality test using Shapiro–Wilk showed that all $p > 0.05$, so the data were distributed normally. The homogeneity test using Levene's Test also showed $p > 0.05$, indicating that the data variance between groups was homogeneous. Full results are presented in Table 7.

Table 7. Normality and Homogeneity Test Results

Test	Statistics	p-value	Interpretation
Shapiro–Wilk Pretest Experiment	0.974	0.699	Usual
Shapiro–Wilk Posttest Experiment	0.934	0.089	Usual
Shapiro–Wilk Pretest Control	0.954	0.265	Usual
Shapiro–Wilk Posttest Control	0.946	0.171	Usual
Levene's Test Pretest	0.118	0.733	Homogeneous
Levene's Test Posttest	0.224	0.638	Homogeneous

An independent sample t-test was used to analyze the effect of Quantum Teaching. The result (t = 4.391; p = 0.000) indicated a significant difference in posttest scores between the experimental and control groups, supporting the hypothesis that TANDUR-based instruction is more effective.

Table 8. Results of the t-test Posttest

Comparison	t	p-value	Interpretation
Posttest (Experiment vs Control)	4.391	0.000	Significant

Beyond the cognitive results, this study also analyzed affective and psychomotor outcomes. As summarized in Table 9, the experimental group consistently outperformed the control group across all domains.

Domain-Based Learning Outcomes

The analysis of learning outcomes is also conducted based on three main domains: cognitive, affective, and psychomotor. The cognitive domain is measured through a written test that tests understanding of the concept of sociocultural diversity. The affective domain was assessed through motivational questionnaires and observation of students' attitudes during the learning process. The psychomotor domain is evaluated through project activities and student performance in compiling and presenting diversity-based value-based learning products. The full results are presented in Table 9.

Table 9. Student Learning Outcomes Based on Three Domains

Group	Cognitive (Score)	Affective (Score)	Psychomotor (Score)
Experiment	78.12	3.29	80.10
Control	70.45	2.71	72.34

The data in Table 9 shows that the experimental group showed superiority in all three domains. Higher cognitive scores indicate a student's in-depth conceptual understanding of the learning material. A high affective score reflects a student's emotional involvement, interest, and responsibility in the learning process. Superior psychomotor scores indicate that students in the experimental group are able to demonstrate better social, collaborative, and performative skills on learning tasks. These findings strengthen the argument that *the Quantum Teaching* method is able to present more meaningful PPKn learning as a whole.

These findings confirm that the implementation of Quantum Teaching positively impacts all learning dimensions. Cognitive improvements demonstrate better conceptual understanding of socio-cultural diversity, as reported in similar studies [37], [38]. Affective outcomes, as shown in the motivation score, reflect students' emotional involvement, interest, and sense of responsibility, aligning with the ARCS motivation model [28] and confirming the findings of previous research [39], [40]. In the psychomotor domain, students in the experimental group actively participated in performance-based learning activities, such as group discussions, presentations, and value-based project creation, reinforcing research [33], [41], [42] that found that Quantum Teaching enhances hands-on skill development and collaborative learning. This is especially relevant in civic education, where behavioral demonstration of values is essential.

From a theoretical standpoint, the study reinforces Vygotsky's [43] Zone of Proximal Development theory, highlighting the role of guided, emotionally supportive instruction in accelerating value internalization. Practically, these findings confirm that TANDUR syntax (Tumbuhkan, Alami, Namai, Demonstrasikan, Ulangi, Rayakan) facilitates learning cycles that are cognitively engaging, affectively resonant, and behaviorally embodied, supporting conclusions from [44]-[46].

Compared to traditional lecture-based approaches, which tend to be passive and less contextual, Quantum Teaching yields better results. This aligns with prior comparative studies [47], [48]. Showing that conventional methods are limited in stimulating reflective thinking, motivation, and behavioral change. Besides that, the Quantum Teaching model demonstrates more significant advantages in building conceptual understanding, emotional engagement, and student performance in the PPKn learning process [44]-[46]. The learning outcomes of students in the control group, who used conventional methods, showed only limited improvement in the cognitive, affective, and psychomotor domains. This indicates that traditional approaches have not been sufficiently practical in meeting the demands of 21st-century learning, which emphasizes active engagement, collaboration, and personal reflection [49], [50].

The implications of this study are threefold. First, it supports the integration of humanistic and constructivist approaches in civic education. Second, it demonstrates how Quantum Teaching aligns with the Merdeka Curriculum, which promotes personalized and differentiated instruction. Third, it emphasizes the importance of socio-emotional learning in developing civic competence in early education. In terms of novelty, this research is among the first to implement the full TANDUR syntax in Indonesian elementary PPKn learning, systematically assessing its effects across cognitive, affective, and psychomotor domains in the context of socio-cultural diversity.

However, some limitations remain. The study was conducted in only two schools from the same district, so generalizability is limited. The intervention was relatively short, and teacher implementation fidelity may vary. Also, as a purely quantitative study, it could not fully capture the process of value internalization. Future research should involve more schools, extend the intervention timeline, and incorporate qualitative methods to explore how students experience and internalize civic values. Integrating digital media into Quantum Teaching also deserves exploration for broader application.

4. CONCLUSION

The findings of this study indicate that implementing the Quantum Teaching method with the TANDUR syntax significantly enhances learning outcomes in civic education across cognitive, affective, and psychomotor domains. This approach encourages meaningful, engaging, and contextual learning processes that foster active participation, emotional involvement, and value-based behaviors among elementary students. The rise in posttest scores and motivation in the experimental group confirms that Quantum Teaching is more effective than traditional methods. These results demonstrate that a holistic instructional model, rooted in the synergy between cognitive development and emotional support, can simultaneously promote character growth and civic competence. Therefore, Quantum Teaching can serve as a valuable alternative approach to support the development of integrated learning outcomes aligned with the demands of 21st-century education. Additionally, the results support the notion that emotionally responsive and structured learning models, such as TANDUR, are suitable for value-based subjects like civic education, especially at the elementary level.

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