

Differentiated Learning with the STEAM Learning Model Towards School Well-Being

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Abstract

Purpose: This study aims to investigate the impact of integrating differentiated learning with the STEAM (Science, Technology, Engineering, Arts, and Mathematics) framework on elementary students' school well-being. It addresses pressing educational challenges in 21st-century Indonesia, particularly in response to low performance indicators highlighted in the 2018 PISA results, by exploring innovative learning methodologies that can foster critical, creative, and collaborative thinking.

Methodology: A quantitative research approach was used to statistically analyze the effect of STEAM-based differentiated learning (independent variable X) on student school well-being (dependent variable Y). The research was conducted among 4th and 5th-grade students from two elementary schools in Surakarta—SD Muhammadiyah 16 Karangasem and SD IT Insan Mulia—using a simple random sampling method to select 220 participants. Data were analyzed using simple regression analysis and t-tests to assess the significance of the learning model's impact on the four dimensions of school well-being.

Results: The analysis revealed that the integration of STEAM and differentiated learning had a statistically significant positive influence on students' well-being in school, particularly across the dimensions of having, loving, being, and health. The results of both the regression and t-tests showed significance values between 0.000 and 0.006, all of which are below the threshold of 0.05, confirming that STEAM-based differentiated learning contributes meaningfully to enhancing student well-being.

Applications/Originality/Value: The study highlights the practical application of STEAM-based differentiated learning as a viable strategy for improving student well-being in elementary education settings. It provides empirical evidence that such an integrated approach not only addresses cognitive development but also supports students' emotional and social needs within the school environment. These findings offer valuable insights for educators and policymakers seeking to implement holistic, student-centered learning innovations in Indonesian schools and similar educational contexts globally.

Introduction Section

Twenty first-century education faces a significant challenge in creating a generation that not only possesses academic skills but also the critical, creative, and collaborative thinking abilities needed in a dynamic global world. According to the 2018 data from the Programme for International Student Assessment (PISA), Indonesia was positioned 74th among 79 countries regarding proficiency in reading, mathematics, and science. This situation highlights the critical necessity for reforming educational methodologies to align more closely with contemporary challenges. The effectiveness of the educational process is determined by various factors, one of which is the choice of learning models or strategies [1]. Learning success can be achieved through the use of new strategies and learning approaches that can capture students' attention and help them learn. [2] A prominent model currently being advanced in the realm of education is the STEAM approach (Science, Technology, Engineering, Arts, Mathematics). This framework seeks to amalgamate multiple disciplines to foster the development of critical thinking, creativity, and collaborative skills among students [3]. However, the implementation of this model in Indonesia is still relatively new, and not much in-depth research has been conducted regarding its impact on overall student engagement. [4]

The implementation of STEAM in Indonesia, despite its potential, still encounters various obstacles. One of the main obstacles is the low readiness of teachers to implement this innovative learning method. A 2020 survey carried out by the Ministry of Education and Culture revealed that 60% of educators in Indonesia continue to depend on the lecture method as their main teaching approach. This technique frequently results in students becoming passive recipients of information, limiting their chances to cultivate essential 21st-century skills, including creativity, critical thinking, and collaboration [5]. Moreover, the low involvement of students in one-way teaching processes such as lectures also has the potential to decrease their motivation to learn and develop non-academic skills that are important for their future lives. [6]. This indicates that there needs to be a significant change in the teaching methods used in Indonesian schools, especially in preparing students to face increasingly complex global challenges.

In addition to the importance of innovation in learning models, the implementation of differentiated learning also becomes an important factor that needs to be considered to enhance student engagement and support school well-being. Differentiated learning is a pedagogical strategy that enables educators to tailor their instructional methods to meet the unique requirements of each student, taking into account their individual learning preferences, interests, and capabilities. With this approach, each student receives a learning experience that aligns with their potential, enabling them to achieve optimal learning outcomes. [7] Research has shown that differentiated learning is not only effective in increasing student engagement and learning outcomes, but also contributes to their emotional and social well-being, as students feel more supported and involved in the learning process. [8] Therefore, combining differentiated learning with the STEAM model can have a significant impact on supporting the overall well-being of students.

One important aspect that is often overlooked in the traditional education process is student well-being, also known as school well-being. School well-being is a concept developed by Konu and Rimpela based on the well-being theory proposed by Allardt. Allardt explains that well-being is a condition when a person's basic needs can be met well, such as material and non-material needs. [9].

Good learning activities are those that can actualize the potential of students holistically, thereby improving their well-being. [10] School well-being encompasses the physical, emotional, social, and academic well-being of students, all of which directly contribute to their performance at school. Based on a UNICEF survey in 2021, around 30% of students in Indonesia reported experiencing high levels of stress related to academic pressure, and felt they received insufficient emotional support from their school environment [11]. This excessive academic pressure has the potential to cause a decline in students' academic performance, an increased risk of mental health issues, and a decrease in their engagement in the learning process. Therefore, efforts to improve student welfare at school become very important, and this is where innovative learning such as STEAM can be a solution.

The concept of school well-being can be defined as a school environment that is safe, comfortable, and enjoyable, aimed at fulfilling the development of students' potential, achievements, and abilities [12]. There are four dimensions of school well-being, namely having, loving, being, and health. Having is a feeling that arises from conditions or situations that affect learning activities. Loving is a feeling that arises from the relationship between students and the learning environment, students with other students, and students with their teachers. Being is the possibility for learners to study based on their own interests and abilities. Health refers to the state in which students do not feel pressured when engaging in learning activities [13]. One of the initiatives undertaken by the school to promote well-being is the development of a learning environment that is tailored to meet the educational needs of its students [14].

The novelty of this research lies in the exploration of the synergy between differentiated learning and the STEAM model in enhancing school well-being. Most previous research has focused more on how the STEAM model can improve students' academic outcomes in various subjects, but only a few have thoroughly discussed the impact of combining these two approaches on students' overall well-being. Research conducted by Nahak and Lawa (2023) demonstrated that implementing differentiated learning within project-based learning frameworks significantly enhances students' critical thinking abilities, a crucial component of the STEAM model. Therefore, this research is expected to provide new insights into how the combination of STEAM and differentiated learning can more comprehensively support student well-being. [6]

Research by [15] shows that the implementation of STEAM adapted with a differentiated learning approach can have a positive impact on students' emotional well-being. Students involved in STEAM learning reportedly have lower stress levels and are more actively engaged in learning activities compared to students who follow traditional learning. [16]. In addition, this study also found that students who learn using STEAM feel more valued and supported in developing their individual abilities, which ultimately contributes to the improvement of their academic learning outcomes. This shows that a learning model that integrates differentiated learning with STEAM can create a more conducive learning environment and support the holistic development of students [17]

By combining these two approaches, this research aims to delve deeper into how differentiated learning applied through the STEAM model can positively impact students' school well-being. Previous research shows that students who feel emotionally supported in the school environment tend to have better academic outcomes and are more engaged in school activities. [18]. Therefore, this research will examine how the combination of STEAM and differentiated learning can create a more conducive learning environment for the physical, emotional, and academic development of students, as well as provide practical recommendations for teachers and policymakers to enhance student well-being in schools in Indonesia. [19]

This study aims to offer valuable insights for the advancement of more inclusive educational approaches and to enhance the well-being of students within educational institutions. Through the STEAM approach and differentiated learning, it is hoped that students will not only achieve better academic results but also feel more supported in their social and emotional aspects. [20]. Thus, this research can serve as a foundation for the development of more holistic educational policies, which not only focus on academic outcomes but also on the overall well-being of students.

Methodology

This research uses a quantitative approach. The quantitative approach was chosen to statistically measure the effect of STEAM-based differentiated learning (variable X) on the dependent variable, school well-being. (variabel Y). The study's population comprises all 4th and 5th-grade students from three elementary schools situated in Surakarta and its vicinity, specifically SD Muhammadiyah 16 Karangasem and SD IT Insan Mulia. This study uses the simple random sampling technique to randomly select 220 students from these two schools. This technique was chosen so that each student has an equal opportunity to be selected as a respondent, allowing the research results to be generalized to the population of 4th and 5th-grade students in Surakarta. This research does not use experimental and control classes; instead, all students receive the same treatment.

The details of the research procedure include initial observations conducted with the school authorities, particularly the principal and class teachers, to obtain research permission and determine the classes to be used. At the implementation stage, the data collection methods used by the researchers are questionnaires, observations, and documentation. The researcher will provide a questionnaire to each student in order to collect information and data regarding differentiated learning based on STEAM in relation to the implementation of school well-being. Each statement in the questionnaire uses a 1-4 Likert scale, where (1) Strongly Disagree, (2) Disagree, (3) Agree, and (4) Strongly Agree. The questionnaire is filled out directly by the respondents, and the researcher ensures that each student understands how to fill out the questionnaire to obtain accurate results, which are then analyzed using relevant statistical tests. Before being used in data collection, the designed questionnaire instrument will be tested first to ensure its validity and reliability. A research instrument is considered good if it meets two important criteria: validity and reliability, thus an instrument trial is necessary. The research instrument trial is conducted to empirically determine whether the instrument is suitable for use. Before being given to the students who are the research sample, several tests will be conducted on the research instrument to obtain a quality test. To determine the feasibility of the research instrument, an instrument test is conducted outside the population used. The instrument test conducted is a validity test and a reliability test. Here are the results of the instrument test:

Validity Test

Validity refers to a data analysis process that assesses the effectiveness of an instrument. The validity assessment employed is the product moment validity test, which entails comparing the computed correlation coefficient (r calculated) against the critical value from the table (r table). An instrument is deemed valid if the computed r value surpasses the table value.

The validity test results for the STEAM instrument indicate that the computed r value is greater than the table value of 0.374, with a significance level below 0.05. Therefore, it can be concluded that the 12 items in the STEAM questionnaire are valid and suitable for use as a research instrument. Similarly, the validity assessment of the school well-being instrument revealed that each computed r value from the 19 questions exceeded the table r value of 0.374, confirming that all 19 questions are valid for research purposes.

Reliability Test

Following the validity assessment, a reliability test is conducted to evaluate the consistency and dependability of the items within the questionnaire. The standard for determining reliability is that a Cronbach's Alpha value exceeding 0.7 indicates that the questionnaire is considered reliable or possesses good reliability.

The reliability test results for the questionnaire revealed a Cronbach's Alpha value of 0.739, which is greater than 0.7. This indicates that the questions included in the STEAM questionnaire are deemed reliable and yield consistent responses. Furthermore, the reliability test calculation produced a Cronbach's Alpha of 0.840. Therefore, it can be concluded that the items in the questionnaire intended for the research are highly reliable and can be regarded as a trustworthy tool for data collection.

Following the completion of validity and reliability assessments, the subsequent phase involves performing prerequisite tests prior to hypothesis testing. These prerequisite tests encompass normality and homogeneity assessments. The normality test is executed utilizing the Kolmogorov-Smirnov method, which aims to ascertain whether the data follows a normal distribution. In contrast, the homogeneity test is performed to evaluate the uniformity of the data. Upon the conclusion of these prerequisite tests, hypothesis testing is conducted through simple linear regression and t-tests. Simple linear regression serves as a statistical method to identify the linear relationship between a single independent variable and the dependent variable by analyzing the unstandardized coefficients in column b [21]. The partial t-test is employed to analyze the individual impact of each independent variable on the dependent variable. Simple regression analyses and t-tests are conducted on this dataset to assess the influence of STEAM-based differentiated learning on the four dimensions of school well-being, which encompass the aspects of feeling, loving, being, and health. Subsequently, the effect of STEAM-based differentiated learning on overall school well-being is evaluated.

Results

Nomality Test

The normality test is employed to assess whether a data distribution conforms to a normal distribution, utilizing residual values as the basis for evaluation [21]. The normality assessment in this study employs the Kolmogorov-Smirnov test. According to the criteria for this test, a significance value exceeding 0.05 indicates that the data follows a normal distribution, whereas a significance value below 0.05 suggests that the data does not conform to a normal distribution.

Table 1. Nomality Test

One-Sample Kolmogorov-Smirnov Test	
Test Statistic	.060
Asymp. Sig. (2-tailed)	.051 ^c

According to the findings of the Kolmogorov-Smirnov normality test, a significance value of 0.051 was observed in this dataset ($0.051 > 0.050$), indicating that the data can be considered normally distributed.

Homogeneity test

The homogeneity test is a statistical procedure employed to assess whether the data collected from a population exhibits homogeneity [22]. The homogeneity assessment of this dataset employs the Levene test. According to the criteria for the Levene test, if the significance value exceeds 0.05, the data is considered homogeneous; conversely, if the significance value is less than 0.05, the data is deemed non-homogeneous.

Table 2. Homogeneity Test

Test of Homogeneity of Variances				
	Levene Statistic	df1	df2	Sig.
differentiated learning based on STEAM	1.583	22	195	.053

The findings from the homogeneity test concerning the differentiated learning variable based on STEAM in relation to school well-being revealed a significance value of 0.053, which exceeds the threshold of 0.050. This indicates that the data is homogeneous.

Data analysis

Simple linear regression is a statistical method used to assess the linear relationship between a single independent variable and a dependent variable by examining the unstandardized coefficients presented in column b [21]. The partial t-test is employed to analyze the individual impact of each independent variable on the dependent variable. According to the evaluation criteria for the t-test, a significance level of less than 0.05 indicates that the variable has a significant effect on the dependent variable. Simple regression analyses and t-tests are conducted on this data to assess the influence of STEAM-based differentiated learning on 4 dimensions of school well-being, namely the aspects of heaving, loving, being, and health. Subsequently, this analysis aims to ascertain the effect of STEAM-based differentiated learning on overall school well-being.

Table 3. Simple linear regression test and t-test

<i>Variable x</i>	<i>Variabel y</i>	<i>T</i>	<i>Sig.</i>
differentiated learning based on STEAM	<i>Heaving aspect</i>	2,763	0,006
	<i>Loving aspect</i>	5,085	0,000
	<i>Being aspect</i>	4,287	0,000
	<i>Health aspect</i>	4,503	0,000
	<i>Scholl well being</i>	6,348	0,000

Tabel 4. Having aspect

Coefficients^a			
	B	t	Sig
(Constant)	14.392	47.816	.000
differentiated learning based on the STEAM aspect	.024	2.763	.006

The t-test results regarding the impact of differentiated learning variables implemented through the STEAM learning model on the aspect of enhancing school well-being revealed a t-value of 2.763 and a significance level of 0.006 ($0.006 < 0.05$). This indicates a significant effect of differentiated learning via the STEAM learning model on the enhancement of school well-being.

Table 5. Loving Aspect

Coefficients^a			
	B	t	Sig
(Constant)	18.852	34.238	.000
differentiated learning based on the STEAM loving aspect	.081	5.085	.000

The t-test results regarding the impact of differentiated learning variables via the STEAM learning model on the aspect of school well-being, specifically the love for school, revealed a t-value of 5.085 and a significance level of 0.00 ($0.000 < 0.05$). This indicates a significant effect of differentiated learning through the STEAM learning model on the aspect of loving school well-being.

Table 6. Being aspect

Coefficients^a			
	B	t	Sig
(Constant)	12.533	33.826	.000
differentiated learning based on the STEAM being aspect	.046	4.287	.000

The findings from the t-test indicate that differentiated learning variables, as implemented through the STEAM learning model, significantly affect the aspect of school well-being. The analysis yielded a t-value of 4.287 and a significance level of 0.00 ($0.000 < 0.05$), demonstrating a substantial impact of differentiated learning on school well-being.

Table 7. Health aspect

Coefficients^a			
	B	t	Sig
(Constant)	16.303	35.197	.000
differentiated learning based on STEAM health aspects	.061	4.503	.000

The t-test results regarding the impact of differentiated learning variables implemented through the STEAM learning model on the aspect of school health well-being revealed a t-value of 4.503 and a significance level of 0.00 ($0.000 < 0.05$). This indicates a significant effect of differentiated learning via the STEAM learning model on the aspect of school health well-being.

Table 8. Scholl well-being aspect

Coefficients^a			
	B	t	Sig
(Constant)	62.080	53.939	.000
differentiated learning based on STEAM aspects of school well-being.	.212	6.348	.000

Based on the constant value of 62.080, which indicates that if the variable school well-being is not influenced by the differentiated learning variable based on STEAM (X), then school well-being (Y) has a fixed value of 62.080.

The results of the regression analysis concerning the differentiated learning variable associated with STEAM (X) indicate a positive regression coefficient of $b = 0.212$. This suggests that a one-point increase in variable X corresponds to a 0.212 increase in the acceptance of school well-being (Y).

Furthermore, the t-test results examining the impact of the differentiated learning variable via the STEAM learning model on school well-being revealed a t-value of 6.348 and a significance level of 0.00 ($0.000 < 0.05$). This indicates a significant effect of differentiated learning through the STEAM model on school well-being.

Discussion

The analysis of the research data revealed the impact of team-based learning on the well-being of students in schools. Steam-based learning is proven to be effective in improving various aspects of student well-being.

Simple linear regression tests and t-tests were conducted to see if there is an effect of *STEAM* learning on *students' school well-being*. The results of the simple linear regression test and t-test showed that in each aspect measured (*having, loving, being, health*), the Asymp. Sig. (2-tailed) is 0.000-0.006, which is smaller than 0.05. This indicates the influence of steam-based differentiated learning on the application of school well-being. Thus, it can be concluded that differentiated learning through the *STEAM* model has a positive influence on improving students' *school well-being*, by the proposed hypothesis.

In the aspect of *having*, it shows a significant effect, which means that students feel more closely related to their environment after the application of *STEAM-based* differentiated learning. This is in line with research [15] which concluded that there is a positive and significant relationship between school well-being and compliance with discipline. The text further clarifies that an increase in the well-being of the school correlates with a higher level of student compliance, and the reverse is also true. This relationship is supported by a correlation coefficient of $r = 0.775$ ($p < 0.05$) and an effective contribution of 57.3%.

In the *loving* aspect, there is a significant effect on students' love for their social environment, which also supports the hypothesis that *STEAM-based* differentiated learning improves students' emotional well-being. This is in accordance with previous research by [23] which states that the *STEAM-based* learning method can encourage students to engage, explore, explain, and find out about the environment around them. Relationships with friends and teachers will also give students positive feelings so that students are happier and enjoy the school situation. The findings of Wijayanti and Sulistiobudi (2018) align with this perspective, indicating that the enhancement of positive emotions is further reinforced by a rational academic learning framework that employs interactive techniques and a practical curriculum or objectives. This approach contributes to the overall psychological well-being of students within the school environment.

In the aspect of *being* students feel more valuable and have clear goals after participating in learning with the *STEAM* approach, as evidenced by the significant influence. Research conducted by [24] suggests that based on observations or student activities can be seen from the results of the percentage of 87% of students enthusiastic in participating in the learning test active in asking questions, and courageous participants in expressing opinions. The achievement indicator has been satisfied with a percentage of 87%. The learning outcomes, as evaluated, are reflected in the results of both the pretest and posttest. The pretest score stands at 70.47%, while the posttest score is 77.14%. These results indicate that the assessment criteria have been met, and there is a notable positive response of 95.85% from students regarding *STEAM-based* learning (Science, Technology, Engineering, Art, and Mathematics). Therefore, it can be concluded that the *STEAM-based* learning process for students in CLASS XII is effective, as evidenced by student engagement, favorable responses, and the attainment of learning outcomes.

Furthermore, in the *health* aspect, there is an improvement in students' physical well-being after the implementation of *STEAM-based* differentiated learning, indicating that this learning not only focuses on intellectual aspects but also supports students' overall health. Overall, hypothesis testing shows that the hypothesis is accepted. This means that the application of the *STEAM* model in differentiated learning significantly improves students' well-being at school. The health dimension also includes physical and mental health, so school well-being can be seen in students whether they are physically and mentally healthy when participating in class learning. [25]. In conclusion, this study supports the fact that the *STEAM* approach is proven to be effective and the results are significant in improving the quality of education, economy, industry, and the welfare of its people, by the statement [24].

The analysis of the coefficient of determination (R^2) presented in the table above indicates that the R^2 value for the *having* aspect is 0.034, suggesting that differentiated learning through the *STEAM* learning model accounts for 3.4% of the variance in this aspect. For the *loving* aspect, the R^2 value of 0.106 implies that the impact of differentiated learning via the *STEAM* model is 10.6%. The coefficient of determination for the *being* aspect reveals an R^2 value of 0.074, indicating that the *STEAM* learning model contributes 7.4% to this aspect. Furthermore, the health aspect shows an R^2 value of 0.085, which means that differentiated learning through the *STEAM* model has an effect of 8.5%. Collectively, the overall R^2 value of 0.156 signifies that differentiated learning through the *STEAM* learning model influences school well-being by 15.6%. This aligns with the findings of Dewi (2021), which suggest that *STEAM-based* learning activities, characterized by project-based approaches, enable students to learn from their mistakes and foster creativity, ultimately enhancing student learning outcomes and promoting well-being.

The results of this study are in line with previous studies showing that the *STEAM* approach can increase student motivation, engagement, and well-being. According to [26], *STEAM* not only encourages students to learn creatively but also increases their emotional engagement with learning. The *STEAM* approach invites students to contribute directly to learning to develop all the skills possessed by students [27], [28] The skills developed will be useful in students' lives in the future. Thus, the results of this study confirm that *STEAM* learning is not only an effective method to improve student's

learning outcomes, but also plays an important role in improving students' holistic well-being, including their emotional, social, and physical aspects.

Conclusion

Twenty first-century education faces the challenge of preparing students with critical, creative, and collaborative thinking skills necessary in the global world. PISA 2018 data placed Indonesia at a low ranking, indicating an urgent need for a renewal of learning approaches, including the implementation of the STEAM model. STEAM has proven to be potential in enhancing students' skills, but still faces challenges such as low teacher readiness. Differentiated learning also plays an important role in enhancing student engagement and school well-being. (school well-being).

The combination of STEAM and differentiated learning has a positive impact on student well-being, encompassing the dimensions of having, loving, being, and health. Simple linear regression tests and t-tests show a significant impact on student welfare aspects after the implementation of differentiated STEAM learning. Students who feel emotionally and intellectually supported in the learning process tend to have higher engagement and better academic outcomes. This research provides practical contributions to the development of more holistic educational strategies, which not only focus on academics but also on the overall well-being of students.

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