SIN-CHN
SCIENTIFIC PRESS PTE.LTD.

Molecular & Cellular Biomechanics 2025, 22(1), 967.
https://doi.org/10.62617/mcb967

Article

Integrating biomechanics and biosensors for enhancing college students' physical health and ideological literacy

Churan Liu

School of Marxism, Zhengzhou Railway Vocational & Technical College, Zhengzhou 451460, China; xinshidai138@126.com

CITATION

Liu C. Integrating biomechanics and biosensors for enhancing college students' physical health and ideological literacy. Molecular & Cellular Biomechanics. 2025; 22(1): 967.
https://doi.org/10.62617/mcb967

ARTICLE INFO

Received: 2 December 2024
Accepted: 12 December 2024
Available online: 8 January 2025

Abstract: College students face a wide variety of challenges in the educational process, including physical and mental stressors, with implications for their overall well-being and academic performance. Ideological and political education (IPE) is an important aspect of higher education, fostering in students a sense of concern for broader societal issues, encouraging politically critical thinking, and promoting responsibility for their communities. However, mental illness undermines such literacy, as it inhibits the ability of students to engage properly with the concepts. It discusses how a biosensor-integrated health education platform can contribute to developing college students' ideological and political literacy (IPL). The platform works by leveraging biomechanics and biosensors to monitor physiological factors, such as heart rate, stress levels, sleep quality, physical activity and biomechanics, making it probable for students to receive real-time feedback on their physiological states. In addition to helping improve students' physical health, the platform also fosters ideological and political literacy by developing self-awareness, resilience, and social responsibility as essential qualities of active citizenship. Regression analysis, descriptive statistics, correlation analysis, and student *t*-tests are used to measure effectiveness. The levels of depression and anxiety among students are also measured. The results show significant correlations between mental health indicators and improvements in ideological and political literacy, which means that the platform has the potential to combine physical health, biomechanics, mental well-being, and moral education into a single comprehensive framework for education. It promotes not only physical but also cognitive and emotional growth for the development of well-rounded, socially conscious individuals through the integration of health data with personalized interventions.

Keywords: health education; biosensor; college students; ideological; political literacy; biomechanics

1. Introduction

The twenty-first century has seen unprecedented advancements in the fields of technology, education, and health sciences, opening up new avenues for addressing the challenging societal concerns [1]. A challenge is the development of a well-rounded IPL among college students. That skill is crucial for encouraging civic engagement, critical thinking, and moral decision-making in an increasingly interconnected society [2]. The foundation for pupils' successful engagement in such intellectual and social growth is similarly provided by their physical and mental health [3]. Health is a comprehensive condition of well-being that allows a person to reach the individual's full potential rather than the absence of sickness [4].

Integrating health education with modern technologies, such as biosensors, offers transformative possibilities. Biosensors are devices that measure physiological parameters in real time, providing valuable insights into both the physical and mental health of students [5]. These technologies can be used in an educational platform to

achieve more than mere monitoring of health but it can actively promote resilience, self-awareness, and social responsibility, all critical elements of IPL [6]. Education has been known as a holistic process, which covers academic learning and also the development of the physical and mental faculties. Higher education is an institution where students are exposed to significant academic and social pressure [7]. Poor physical health, stress, and challenges in mental health can adversely affect cognitive performance, emotional regulation, and social interaction, which are considered important in meaningful learning [8].

Biosensors are devices that can measure biological signals such as blood pressure, blood glucose, heart rate, and brain activity. It converts physiological data into useful information for real-time monitoring and feedback [9]. Biosensors have been prominent in several fields such as health care, fitness, and sports because they offer the chance to give a personal understanding of an individual's health. The process of developing IPL is inherently complex; it requires not only intellectual but also emotional and social growth [10]. Students have to learn resilience in dealing with conflicting points of view, empathy toward understanding the experiences of others, and a sense of responsibility in acting for the public good. All of these qualities are intertwined very closely with physical and mental health.

Despite the possibilities, the integration of biosensors into health education platforms is marked by several limitations. Adaptability is limited by apprehensions regarding the collection of sensitive physiological data and its subsequent use. The cost may pose a limitation to access for underprivileged students. Additionally, educators would require extensive training to effectively utilize these technologies, and cultural or institutional resistance to change could delay their implementation. Overcoming these challenges would be necessary to maximize platform impact. The objective is to improve college students' political and ideological literacy by developing and accessing a health education platform that incorporates biosensors. Through physical health improvement, self-awareness, and resilience, the platform addresses problems related to mental health to help increase student interest in moral and civic education.

The remaining research elements are organized into the following distinct parts. In part 2, research relevant is discussed, covering a wide-ranging background and literature review of studies pertinent to the problem. Part 3 discusses methodology, in terms of data collection, question formulation, and statistical analysis. In part 4, findings are reported, discussing the implications. The research is concluded in Part 5 with a summary of the primary results and a discussion of their effects.

2. Related work

Students' academic achievement and their drive in ideological and political education were affected by the Modular Object-Oriented Dynamic Learning Environment denoted as MOODLE electronic learning system [11]. 447 students from Chinese universities participated. It measured student achievement, motivation, and educational activities using a variety of techniques. It reached a finding that e-learning platforms could improve student engagement and academic achievement that the motivating element was essential for success in those domains.

The effect of the complex network environment on the psychological development of college students [12]. According to the report, 47.1% of college students utilized the internet, were more socially responsible. Ninety percent of college students also suffer from anxiety and despair. It highlighted the difficulties presented by the network ecology and false information and recommended that college students receive IPE.

The current status of psychological, political, and ideological learning among college students in the digital era. It identified several difficulties in these domains using a variety of research techniques. Although the Internet raises the quality of instruction, it was ineffective, because of the professionalism of teachers [13]. By resolving these problems and offering insightful knowledge for the information environment, it emphasized the necessity of better IPE.

The IoT was suggested to assist the patients in receiving the appropriate care through wearable technology. The IoT used in many healthcare activities, such as biosensor-based illness monitoring, diagnosis and therapy [14]. Many individuals have numerous restrictions throughout their treatment because of the inadequate technology in healthcare facilities. The experimental outcome demonstrated a successful reduction in the extra cost of medical expenses.

The Internet connection affects the ideological and mental health education (IMHE) of college students [15]. It was discovered that the internet is the most significant source of information, with nearly half of the students spending two to five hours online each day. Classroom instruction, discussions, and instructive videos were common IMHE formats. Cognitive and behavioral communication are greatly impacted by internet use during ICD, with emotional aspects having the greatest impact.

An artificial intelligence teaching assessment index system for university courses on political and ideological theory [16]. It examined the requirements of the model using dimensional analysis, machine learning methods, and data mining technology. A hybrid optimization approach was used to evaluate the model's performance, and the findings indicated that it achieved anticipated objectives and it was attainable.

The nanoparticles were used to improve the biosensors by using its electric and optical grid capabilities as plasmonic units [17]. The fundamental aspects of designing and selecting flexible substrates, integrating flexible plasmonic components and encompassing different kinds of adaptable plasmonic biosensors used in colorimetric and Surface-enhanced Raman scattering (SERS) for blood glucose and temperature monitoring. According to the findings, adaptable optical biosensors enhanced the quality of life.

Institutions of higher study merged political and ideological teaching with mental wellness education. These classes were essential for raising college students' standards and encouraging positive development [18]. They had connections even though they are distinct educational backgrounds. These courses must be taken together to promote students' talents and general growth.

College students' physical and emotional well-being has been profoundly impacted by the internet's explosive growth. A novel approach to psychological health education has been created to enhance students' mental well-being [19]. The current issues and suggested a practical to develop a new approach to mental health education

for college students in a network setting. The goal of the creative strategy was to improve college students' psychological well-being.

The identification of biomarkers linked to diseases offers comprehensive healthcare information and aids in illness management [20]. Development of a minimally invasive platform that could directly detect various biomarkers in body fluid. The experimental outcome demonstrated that biosensors might concurrently detect many biomarkers.

Using a separable CNN to identify looked-in images, deep learning (DL) student emotion detection model was created [21]. The findings indicated that while social practices and campus culture have a beneficial impact on political entity identity, demographic features have a substantial impact. When compared to conventional machine learning techniques, the strategy has increased classification accuracy by 8.036%.

College students' ideological processes had undergone significant change as a result of social environment effects, and psychology-receiving mechanisms were distinct from self-perception [22]. With a focus on humanistic treatment and psychological counseling, China's 17th National Congress seeks to improve ideological and political education. Jiang [22] examined psychological education and provided guidelines and metrics for creative teaching approaches.

Among Chinese college students the reducing impact of ideological determination and politically motivated digital dependencies on the relationship between psychological wellness and mental wellness education [23]. This conducted with 750 surveys found that intellectual intensity and dependency on the internet significantly strengthened the relationship between mental well-being and mental health among undergraduates.

College students' employment and entrepreneurial mindsets were affected when mental health information was incorporated into ideological and political instruction [24]. It examined the psychological and ideological states of university pupils from divorced structures. According to the findings, 64.63% of urban students consider entrepreneurship to be a learning tool that ought to be promoted, whereas 30% of students from split people found big groups difficult.

Modernizing Ideological and Political Education (IPE) courses at colleges and universities by utilizing data mining and artificial intelligence (AI). It examined the administration of the Internet, multivariate space-time, standard value, and interdependent subjectivity [25]. By absorbing and evaluating DM-AI knowledge, administrators could promptly acquire important information and offer solutions for decision-making, allaying the timeliness issues associated with IPE transformation.

3. Methodology

The design, data collection, questionnaire design, and statistical analysis techniques utilized to assess the role of a health education platform integrated with biosensors in enhancing college students' IPL are described in this section. **Figure 1** shows the Overall paper flow for ideological and political literacy.

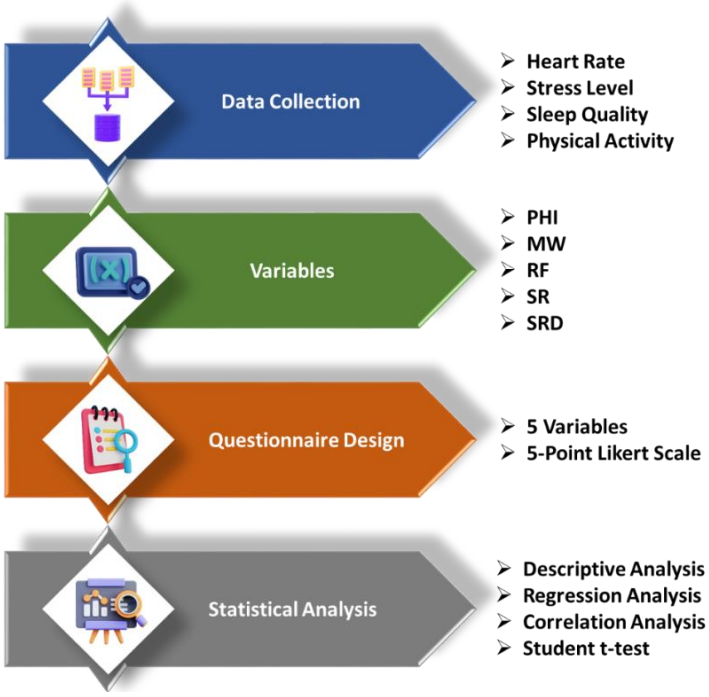

Figure 1. Overall paper flow.

3.1. Research design

It represents a quantitative research project applied through a structured survey gathering extensive data from college students. This approach enables students' systematic evaluation of all factors that contribute to a student's ideological and political literacy, including physical health, mental well-being, real-time feedback, self-awareness, resilience, and development of social responsibility. The survey comprises questions for the analysis of relationships among these variables and students' engagement with political, social, and moral education to provide insight into how integrated health interventions can cultivate well-rounded, socially responsible individuals. **Figure 2** demonstrates the variables of students' ideological and political literacy.

Physical health improvements (PHI): It is an improvement in students' physical well-being, including improvements in physical activity, sleep, and heart rate regulation the ability to manage stress. It improves general health, which subsequently enhances mental and cognitive performance and thus promotes academic and personal development.

Mental well-being (MW): Mental well-being involves a reduction in negative emotions such as stress, anxiety, depression and an increase in positive mental states. It involves aspects such as emotional resilience and coping mechanisms, as well as psychological stability in general and it would impact how students receive and process educational content.

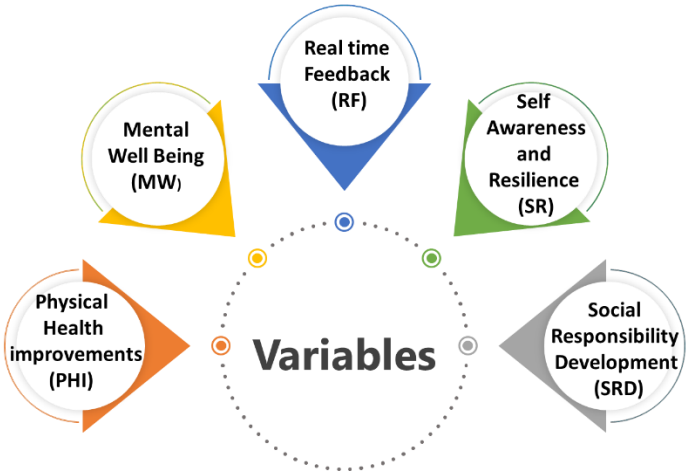

Figure 2. Variables of students' ideological and political literacy.

Real-time feedback (RF): Real-time feedback involves the continuous monitoring and reporting of students' physiological data, such as heart rate, stress levels, and physical activity. This helps them understand and manage their health better, making it possible to make timely adjustments that can support both physical and mental well-being.

Self-awareness and resilience (SR): Self-awareness and resilience describe the capacity of students to become aware of their physical, emotional, and cognitive states and to develop resilience to better cope with stress. The improvement in self-awareness and the building of resilience helps the student better navigate stress and able to engage more successfully in academic and social activities.

Social responsibility development (SRD): The development of social responsibility involves creating a sense of duty and ethical responsibility toward society and the community. It focuses on understanding societal issues, community service, and active roles in dealing with social, political, and environmental challenges. This variable explains how education contributes to making responsible, active citizens.

3.2. Data collection

The biosensor dataset involves in-depth physiological and psychological information gathered from the participants as well as demographic details for context. Every participant has a unique participant ID and demographic information, like age, gender, academic year, and major to investigate any possible correlation that could exist between these variables. The heart rate (bpm) is the average participant's heart rate during the biosensor monitoring session. Stress level and sleep quality are self-rated scores to measure the perceived level of stress of participants and quality of sleep. Anxiety levels expressed on a scale ranging from 0 (no anxiety) to 10 (extreme anxiety), were assessed through a standardized psychological tool. Anxiety levels were expressed on a scale ranging from 0 to 10, and depression levels on a scale from 0 (no depression) to 10 (severe depression), were assessed through a standardized psychological tool. These variables offer an overall view of the mental and physical health of each participant, allowing the influence of these factors to be analyzed in terms of IPE and other key outcomes.

The biosensor dataset contains other physiological measures including heart rate during exercise, which gives information on how people's cardiovascular systems react to physical strain. Blood pressure readings were used to evaluate the cardiovascular health of the participants. Blood lipid profiles were gathered to assess metabolic health and cardiovascular risk. Blood sugar levels were measured to assess metabolic function, especially in connection with physical activity, anxiety and depression. Physical activity tracks the time participants spend doing physical activity in a day as monitored by the biosensor. These variables interact and influence individuals' well-being made possible by the comprehensive perspective of physiological health. **Table 1** shows the participant demographics and health-related data.

Table 1. Participant demographics and health-related data.

Participant ID	Age	Gender	Academic Year	Major	Heart Rate (bpm)	Stress Level (0–10)	Sleep Quality (0–10)	Physical Activity	Anxiety Level (0–10)	Depression Level (0–10)
001	20	Male	2nd Year	Psychology	75	4	8	30	3	4
002	22	Female	3rd Year	Biology	80	5	7	45	5	6
003	21	Male	1st Year	Engineering	70	3	9	40	2	3
004	23	Male	4th Year	History	85	6	6	60	6	7
005	20	Male	2nd Year	Literature	78	4	8	50	4	5
006	24	Female	3rd Year	Sociology	72	5	7	55	4	5
007	19	Male	1st Year	Computer Sci	68	2	9	35	3	2
008	22	Male	2nd Year	Engineering	80	7	5	50	6	6
009	21	Female	3rd Year	Political Sci	77	6	6	40	7	6
010	23	Female	4th Year	Psychology	82	4	8	65	5	4

Gathered information from 346 people in the sample dataset, including their age, gender, academic year, field of research, health status, and political activity. Age distinct into three categories as 18–20, 21–23 and 24+. Gender into two categories as male and female. Health conditions distinct into two categories such as No pre-existing conditions and Pre-existing conditions. Political Involvement divided into two categories such as active and Inactive. With a roughly equal distribution of genders and representation across all academic fields and years, the majority are between the ages of 21 and 23. More than half of the participants are actively engaged in social or political activities, and the majority have no pre-existing medical issues. **Table 2** illustrates the demographic and health characteristics of participants. **Figure 3** shows the percentage of major and political involvement.

Table 2. Demographic and health characteristics of participants.

Variable	Category	Frequency (*n*)	Percentage (%)
Age	18–20	120	34.7%
	21–23	160	46.2%
	24 and above	66	19.1%
Gender	Male	170	49.1%
	Female	176	50.9%
Academic Year	1st Year	90	26.0%
	2nd Year	100	28.9%
	3rd Year	95	27.5%
	4th Year	61	17.6%
Major	Psychology	70	20.2%
	Engineering	80	23.1%
	Biology	50	14.5%
	Political Science	60	17.3%
	Sociology	40	11.6%
	Other	46	13.3%
Health Condition	No pre-existing conditions	300	86.7%
	Pre-existing conditions	46	13.3%
Political Involvement	Active	200	57.8%
	Inactive	146	42.2%

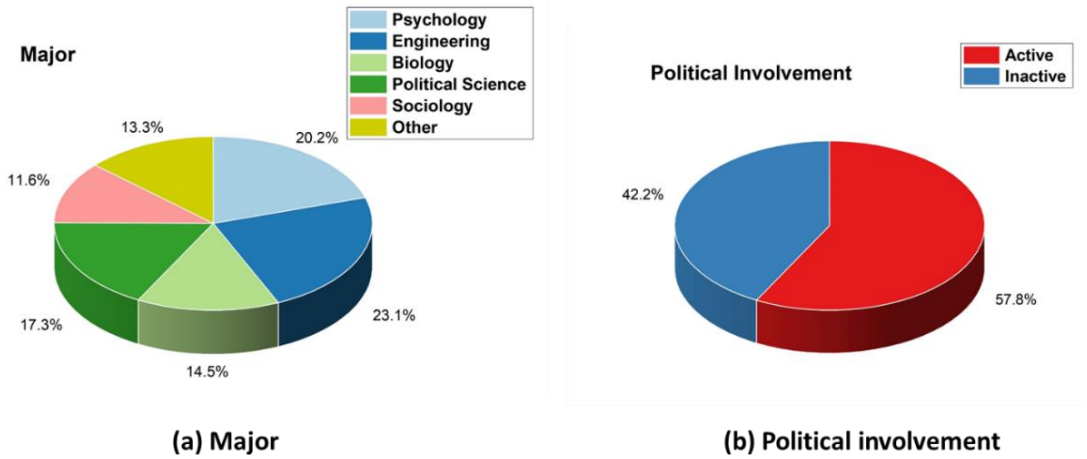

Figure 3. Percentage of **(a)** major; **(b)** political involvement.

3.3. Questionnaire design

The structured questionnaire was designed to collect data on five critical variables: Physical Health Improvements (PHI), Mental Well-being (MW), Real-time Feedback (RF), Self-awareness and Resilience (SR), and Social Responsibility Development (SRD). Every variable is defined in detail to ensure clarity for the respondents, thereby providing the best possible answers according to their experiences and perceptions. A 5-point Likert scale was utilized for most items. Participants were able to give an extent of agreement or a frequency of certain behaviors. The questionnaire is designed to probe the relationship between these

factors-physical health, mental well-being, and personal development improvements in ideological and political literacy. It is based on understanding the health interventions to become effective in bringing socially responsible graduates. Detailed information about the questionnaire is available in Appendix.

3.4. Statistical analysis

The SPSS program was used to examine the data for the inquiry. Descriptive analysis, the student *t*-test, regression analysis, and correlation analysis are used to evaluate the relationship between the variables.

- Regression analysis

It will be used in analyzing the relationships of key factors. Regression analysis helps identify how such factors influence each other and offers a model for understanding how changes in one factor might impact others.

- Descriptive statistics

Descriptive statistics will summarize the key characteristics of the collected data. It will include measures such as $M, SD,$ and ranges to describe the distribution and central tendency of participants' responses, which will provide insights into general trends and variability.

- Correlation analysis

Correlation analysis will observe the relationship between the variables. Using this technique, the relationship and strength of the associations are known, which will define the degree of interdependence among these variables.

- Student *t*-tests

Student *t*-tests will be applied to two entirely different groups in the form of responses about the factors studied. It would determine whether the quantity of the important variables in each category differs significantly from one another.

4. Results

To examine the variables is carried out using correlation analysis, regression models, student *t*-tests, and descriptive statistics.

4.1. Descriptive statistics analysis

Descriptive statistics is the process of summarizing and organizing data, which indicates the sample in a short and clear manner. It is applied to describe the basic features of the data, such as variability (SD, range), central tendency ($M, median$), and the shape of the distribution. Descriptive statistics is applied to make the data more understandable and provide the initial insight into patterns and trends.

Descriptive statistics have been applied to summarize and organize data. This helped in presenting the clear perceptions and experiences of participants concerning physical health, mental well-being, and personal development. Calculations such as the M and SD enabled us to capture central tendencies and variability in data. **Table 3** and **Figure 4** represent the result of different variable's descriptive statistics analysis.

Table 3 presents the mean and standard deviation of each research variable to give an overview of the responses of the participants. The descriptive statistics of five variables such as PHI, MW, RF, SR and SRD reveal key insights into participants'

experiences and perceptions. Physical Health Improvements (PHI) has a $M\ of$ 3.85 and an SD of 0.60, indicating a positive response with moderate variability. Although there might be some fluctuation, the comparatively low SD indicates that most individuals typically report comparable gains in physical health. Mental Well-being (MW) shows an M of 3.90 and an SD of 0.55, suggesting generally positive experiences with slight variation in responses. The participants' subjective gains in mental health were consistent, as indicated by the low *SD*. The M for Real-time Feedback (RF) is the highest at 4.20, showing effective feedback, with an SD of 0.50, which shows consistency in responses. The high degree of consistency indicates that most participants had comparable experiences with real-time feedback. Self-awareness and Resilience (SR) has an M of 4.10 and an SD of 0.45, which shows improvement with closely grouped responses. Social Responsibility Development (SRD) has the lowest M of 3.75 but still indicates a positive outcome, with a higher SD of 0.65, suggesting more variability in perceptions. SRD received high ratings, and varied more significantly from participants. These indicators offer insights into the central tendencies and variability of the participants' responses across the five variables.

Table 3. Results of different variables descriptive statistics analysis.

Variables	**Mean (*M*)**	**Standard Deviation (*SD*)**
Physical Health Improvements (PHI)	3.85	0.60
Mental Well-being (MW)	3.90	0.55
Real-time Feedback (RF)	4.20	0.50
Self-awareness and Resilience (SR)	4.10	0.45
Social Responsibility Development (SRD)	3.75	0.65

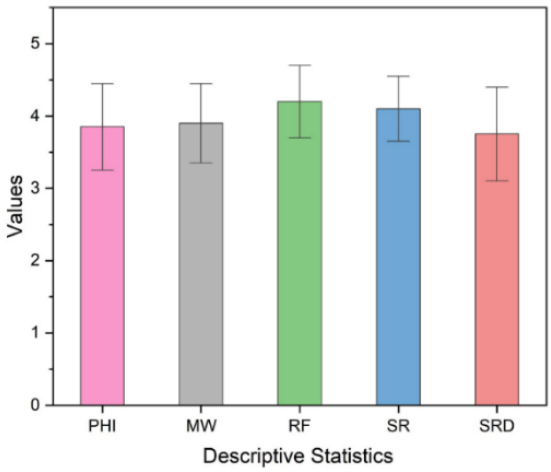

Figure 4. Result of different variables descriptive statistics analysis.

4.2. Regression analysis

It can be used statistically to investigate the connection among one or more variables. Also it employed to determine the associations between the variables and how they affect the desired outcome. It is feasible to ascertain the direction and intensity of the correlations between the variables by using this approach. Apply

regression analysis to assess how changes in the variables affect the IPL of the respondents. The method will enable us to establish whether factors such as physical health, mental well-being, and social responsibility development contribute significantly to improvements in ideological and political literacy. It will also enable to quantification of these relationships to predict how adjustment in one factor can impact other factors. **Table 4** and **Figure 5** represent the results of different variables regression analysis.

Table 4. Results of different variables regression analysis.

Variable	Coefficient (β)	Standard Error	*t*-value	*p*-value	Significance
PHI	0.35	0.12	2.92	< 0.01	Significant
MW	0.40	0.10	4.00	< 0.01	Significant
RF	0.25	0.09	2.78	< 0.01	Significant
SR	0.30	0.08	3.75	< 0.01	Significant
SRD	0.15	0.07	2.14	< 0.01	Significant

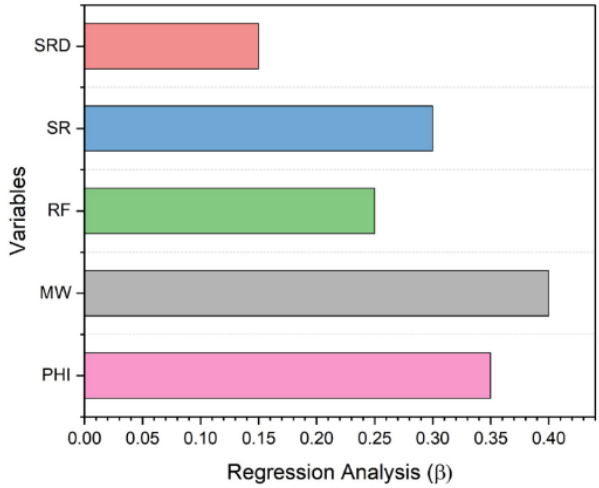

Figure 5. Result of different variables regression analysis.

The regression analysis **Table 4**, there is a relationship among different variables of Ideological and Political Literacy. IPL was greatly influenced by a number of elements, each of which has a favorable impact. A one-unit increase in PHI translates into a 0.35 increase in IPL and has a *p*-value smaller than 0.01. Among all the variables, the MW shows the strongest effect and indicates that it significantly enhances the IPL with a coefficient value of 0.40 and a *p*-value lower than 0.01. A large coefficient of 0.25 with a *p*-value smaller than 0.01 using Real-time Feedback supports it to be significant towards IPL. Self-awareness and resilience are positively contributing factors of 0.30 in enhancing IPL, supported with significance by a *t*-value and a *p*-value. SRD finally happens to have the least significant contribution being 0.15 along with a *t*-value and a *p*-value of 2.14 and.0.01 respectively. All the variables are statistically significant, with *p*-values below 0.05, which means they positively impact IPL. Encouraging students' psychological, mental and physical growth through focused interventions might be a potent strategy for raising the level of IPL. This result

is very important in terms of physical, mental, and personal development to improve students' ideological and political literacy.

4.3. Correlation analysis

The purpose of correlation analysis is to identify the magnitude and pattern of an interaction between two or more variables. The degree of association between the variables and IPL can be determined with the aid of correlation analysis. A high correlation between these variables would indicate that changes in these variables are closely associated with changes in IPL. Correlation analysis is important since it allows to discovery of patterns or relationships between variables. Understanding these relationships would help in designing interventions on ways to improve IPL by targeting areas that have the strongest relationship with it. Correlation analysis is also useful for identifying multicollinearity, or whether two independent variables are highly correlated with each other, which could affect the interpretation of regression results. While the correlation analysis assists more in exploring the relationship between variables, it assists in more appropriate planning and intervention design, for improving IPL. Correlation analysis **Table 5** and **Figure 6** present the different variables correlation coefficients (*R*-values) for the relationship between the research variables.

PHI and MW are positively correlated at 0.68, and thus changes in physical health are partly related to better mental well-being. PHI and RF are strongly correlated with each other at a positive association of $r = 0.72$; this shows that physical health is significantly related to the quality of the real-time feedback. PHI and SR correlate at a moderate level ($r = 0.61$), which implies that positive changes in physical health have moderate associations with self-awareness and resilience. PHI and SRD correlates are relatively low at $r = 0.55$, which means that even though physical health and social responsibility correlate positively, it is still relatively weaker compared to other variables. MW and RF have a strong positive correlation ($r = 0.77$), indicating that better mental health is strongly associated with more effective real-time feedback. MW and SR also have a strong positive relationship ($r = 0.72$), indicating that improved mental well-being is strongly tied to better self-awareness and resilience.

MW and SRD show a moderate positive correlation ($r = 0.62$), indicating that mental well-being has a moderate relationship with social responsibility development. RF and SR have a moderate correlation ($r = 0.65$), meaning that real-time feedback and self-awareness and resilience are somewhat related, though not as strongly as other pairs. RF and SRD show a moderate correlation ($r = 0.58$), indicating a moderate association between feedback and social responsibility. SR and SRD had a strong positive correlation ($r = 0.69$), indicating that self-awareness and resilience are somehow linked directly with social responsibility. Overall, the correlations reveal that the variables are related to one another, and the highest connections were found between MW and RF ($r = 0.77$), as well as between PHI and RF ($r = 0.72$). Such evidence indicates that the changes in physical health and mental well-being are key factors determining the other components of student development, including resilience, feedback, and social responsibility.

Table 5. Results of different variables correlation analysis.

Variable	PHI	MW	RF	SR	SRD
PHI	1.00	0.68	0.72	0.61	0.55
MW	0.68	1.00	0.77	0.72	0.62
RF	0.72	0.77	1.00	0.65	0.58
SR	0.61	0.72	0.65	1.00	0.69
SRD	0.55	0.62	0.58	0.69	1.00

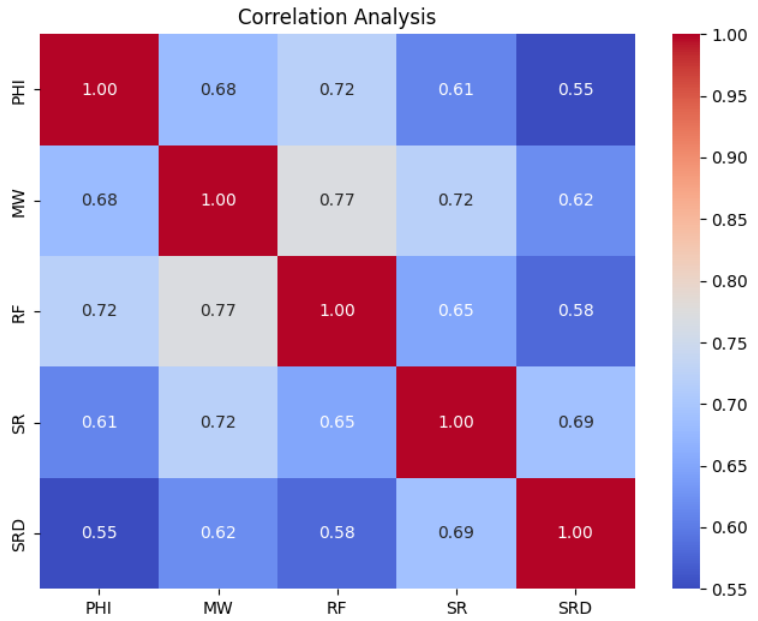

Figure 6. Results of different variables correlation analysis.

4.4. Student *t*-test

The student *t*-test is used to compare the means of the variables between two conditions or groups, for instance, comparing pre-intervention with post-intervention, or student groups. The test will indicate whether any such differences are present. The student t-test to perceive if the mean values of the variables PHI, MW, RF, SR, and SRD are significantly different between two groups of participants: for instance, those with high vs. low levels of health or well-being. For example, compare these variables between two groups of students, those with high academic performance (HAP) and those with low academic performance (LAP). Then we will use a *t*-test to perceive if there is a significant difference in the means of Real-time Feedback (RF) and its associated variables like Physical Health Improvements (PHI), Mental Well-being (MW), etc. The findings of statistical analyses comparing two groups for a variety of variables such as HAP and LAP. PHI shows a *t*-statistic of 4.06, indicating a highly significant difference between HAP and LAP. MW has a *t*-statistic of 3.25 demonstrating a statistically significant difference. RF has a *t*-statistic of 5.12 representing a highly significant difference between the two groups. SR has a *t*-statistic of 2.82, reveals a statistically significant difference. SRD (has a *t*-statistic of 3.50, showing a significant difference between HAP and LAP. **Table 6** and **Figure 7** represent the results of different variables *t*-test.

The student *t*-test results for the comparisons between groups with high academic performance and low academic performance indicate a highly significant difference in all the variables. The Physical Health Improvements (PHI) variable yielded the highest *t*-statistic value, which was 4.06. The *p*-value was 0.0001, indicating a very high significant difference between the two groups. Similarly, Mental Well-being (MW), Real-time Feedback (RF), Self-awareness and Resilience (SR), and Social Responsibility Development (SRD) also reveal statistically significant differences with *p*-values well below the 0.05 threshold, indicating that the intervention of academic performance has a significant impact on these variables. These findings suggest measurable and meaningful effects of the provision of academic performance on students' physical health, mental well-being, real-time feedback experience, self-awareness, and social responsibility development, providing support for the effectiveness of educational interventions.

Table 6. Results of different variables *t*-test.

Variables	*t*-Statistic	Degrees of Freedom (df)	*p*-value
PHI (HAP vs LAP)	4.06	58	0.0001
MW (HAP vs LAP)	3.25	58	0.002
RF (HAP vs LAP)	5.12	58	0.0001
SR (HAP vs LAP)	2.82	58	0.007
SRD (HAP vs LAP)	3.50	58	0.001

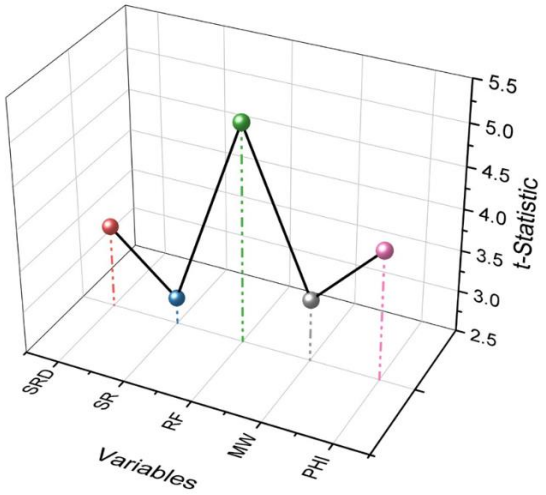

Figure 7. Results of different variables *t*-test.

5. Discussion

The results of the statistical tests conducted show that real-time feedback significantly increased the improvements in students' PHI, MW, real-time feedback experience, self-awareness and resilience, and the development of social responsibility. The descriptive statistics highlighted that RF had a mean value of 4.20 to indicate a strong positive response from the participants. The regression indicates that RF has a meaningful contribution to the improvement in IPL with a coefficient of 0.25 and a *p*-value less than 0.01. The positive correlation analysis indicates that RF

is highly positively correlated with several other variables, such as MW where $r = 0.77$, and PHI which has a correlation of $r = 0.72$, whereby improvements in physical health and mental well-being, are strongly associated with more effective feedback. Student t-test further strengthens this observation. The *t*-values reflect highly significant inter-group differences between groups with HAP and LAP, particularly with PHI ($t = 4.06,\ p = 0.0001$), MW ($t = 3.25,\ p = 0.002$), and RF itself ($t = 5.12, p = 0.0001$), signifying that the actual feedback drives performance on all the variables being considered. These findings reiterate the need for the implementation of real-time feedback as part of educational interventions toward better holistic development and ideological and political literacy.

6. Conclusion

A crucial element of higher education is IPE, which inspires students to critically examine political and social concerns, engage with larger societal issues and develop an awareness of social responsibility. Investigated the design and implementation of a health education platform integrated with biosensors to enhance college students' ideological and political literacy. The platform, which monitors physiological parameters such as heart rate, stress levels, sleep quality, and physical activity, provides real-time feedback to students. Beyond improving physical health, the platform aims to cultivate self-awareness, resilience, and social responsibility key traits for active citizenship. It used regression analysis, descriptive statistics, correlation analysis, and student *t*-tests to assess the effectiveness of the platform. The findings indicated that there were strong correlations between mental health indicators, including depression and anxiety levels, and improvements in IPL. This would indicate the potential of the platform to integrate physical health, mental well-being, and moral education into a unified educational framework. The platform fosters healthy living, cognitive growth, and emotional growth by combining health information with personalized interventions to eventually develop well-rounded and socially conscious individuals.

It suffers from the limitations of reliance on self-reported data that could be biased and short intervention duration, which cannot capture long-term effects. The efficacy of the platform for a range of demographic groups is not examined in this research. Future research could expand the application of the platform for diverse populations, include advanced AI-driven analytics for personalized interventions, and assess the long-term impact on IPL through longitudinal studies.

Ethical approval: Not applicable.

Conflict of interest: The author declares no conflict of interest.

References

1. Srivastava, S., 2023. The evolution of education: Navigating 21st-century challenges. International Journal for Multidisciplinary Research, 5(5), pp.1-9.
2. Wang, W., 2023. Research on Ideological and Political Education in Universities under the. Adult and Higher Education, 5(17), pp.80-85.

3. Gong, Q., 2023. Research on the Ideological and Political Education of College Students in the New Era Based on Health Education. Adult and Higher Education, 5(20), pp.121-128.
4. Dong, Z., Chen, B. and Jiang, A., 2024. The Essence and Implementation of Ideological and Political Education within College English Curricula: A Grounded Theory Analysis. Journal of Educational Technology and Innovation, 6(2).
5. Wang, L. and Yan, Y., 2023. Integration Research of Integrity Education and Ideological and Political Education in Higher Education. Adult and Higher Education, 5(19), pp.55-61.
6. Jiao, C., 2024. A mental health monitoring system based on intelligent algorithms and biosensors: Algorithm behavior analysis and intervention strategies. Molecular & Cellular Biomechanics, 21(1), pp.357-357.
7. Geng, Y., 2024. Comparative Study on Physical Education Learning Quality of Junior High School Students Based on Biosensor Network. Natural and Engineering Sciences, 9(2), pp.125-144.
8. Smith, A.A., Li, R. and Tse, Z.T.H., 2023. Reshaping healthcare with wearable biosensors. Scientific Reports, 13(1), p.4998.
9. Vo, D.K. and Trinh, K.T.L., 2024. Advances in Wearable Biosensors for Healthcare: Current Trends, Applications, and Future Perspectives. Biosensors, 14(11), p.560.
10. He, L. and Han, S., 2024. Application of wearable nano biosensor in sports. Molecular & Cellular Biomechanics, 21(1), pp.165-165.
11. Yang, H., 2024. E-learning platforms in ideological and political education at universities: students' motivation and learning performance. BMC Medical Education, 24(1), p.628.
12. Yao, W., 2023. Optimization of Ideological and Political Education Courses for College Students and Strategies for Mental Health Education. Psychology Research and Behavior Management, pp.1023-1035.
13. He, X., Dong, X., Liu, L., and Zou, Y., 2021. Challenges of College Students' ideological and political and psychological education in the information age. Frontiers in Psychology, 12, p.707973.
14. Verma, D., Singh, K.R., Yadav, A.K., Nayak, V., Singh, J., Solanki, P.R. and Singh, R.P., 2022. Internet of Things (IoT) in nano-integrated wearable biosensor devices for healthcare applications. Biosensors and Bioelectronics: X, 11, p.100153.
15. Chen, J., 2024. Impact of internet contact on the ideological and mental health education of university students. Humanities and Social Sciences Communications, 11(1), pp.1-6.
16. Yin, Y., 2021. Research on ideological and political evaluation model of university students based on data mining artificial intelligence technology. Journal of Intelligent & Fuzzy Systems, 40(2), pp.3689-3698.
17. Song, L., Chen, J., Xu, B.B. and Huang, Y., 2021. Flexible plasmonic biosensors for healthcare monitoring: Progress and prospects. ACS nano, 15(12), pp.18822-18847.
18. Ding, Y., 2020. Strategies of a combination of ideological and political education and psychological health education for college students. J. Contemp. Educ. Res, 12, pp.85-89.
19. Han, X., 2020. Research on the new mode of college students' mental health education under the network environment. Journal of Contemporary Educational Research, 4(8).
20. He, R., Liu, H., Fang, T., Niu, Y., Zhang, H., Han, F., Gao, B., Li, F. and Xu, F., 2021. A colorimetric dermal tattoo biosensor fabricated by microneedle patch for multiplexed detection of health-related biomarkers. Advanced Science, 8(24), p.2103030.
21. Liu, C. and Yang, L., 2022. Analysis of college students' ideological and political education based on network hot topics. Adult and Higher Education, 4(2), pp.46-51.
22. Jiang, H., 2021. New characteristics of college students' ideological dynamics and innovation of ideological and political education methods based on psychological education. Journal of Contemporary Educational Research, 5(6), pp.66-70.
23. Meng, S., 2022. Role of politically motivated internet addiction and ideological passion in Linking college Students's mental health education and wellbeing. Frontiers in Psychiatry, 13, p.973520.
24. Zhu, J., Lei, L., Wu, P., Cheng, B., Yang, X.L., Fu, J., Wu, Z. and He, F., 2022. The intervention effect of mental health knowledge integrated into ideological and political teaching on college students' employment and entrepreneurship mentality. Frontiers in Psychology, 13, p.1002468.
25. Dong, F. and Dong, S., 2023. Research On the Optimization of Ideological and Political Education in Universities Integrating Artificial Intelligence Technology Under the Guidance of Curriculum Ideological and Political Thinking. ACM Transactions on Asian and Low-Resource Language Information Processing.

Appendix

Table A1. Survey questionnaire on the impact of biomechanics and biosensors.

Variable	Questions	Likert scale
Physical Health Improvements (PHI)	Q1: How much do you believe your physical activity levels have improved due to the intervention?	1: No improvement, 2: Slight improvement, 3: Moderate improvement, 4: Significant improvement, 5: Extreme improvement
	Q2: How effectively do you feel the program has helped you manage stress and improve sleep?	1: Not effective at all, 2: Slightly effective, 3: Neutral, 4: Effective, 5: Very effective
Mental Well-being (MW)	Q1: To what extent do you feel the intervention has reduced negative emotions such as stress, anxiety, or depression?	1: Not at all, 2: To a small extent, 3: To a moderate extent, 4: To a large extent, 5: To a very large extent
	Q2: How much has the program helped you improve your emotional resilience and coping mechanisms?	1: Not at all, 2: Slightly, 3: Moderately, 4: Significantly, 5: Extremely
Real-time Feedback (RF)	Q1: How useful do you find the real-time feedback provided by the platform regarding your physiological data (e.g., heart rate, stress levels)?	1: Not useful, 2: Slightly useful, 3: Moderately useful, 4: Very useful, 5: Extremely useful
	Q2: How often do you make adjustments in your health behavior based on the real-time feedback you receive?	1: Never, 2: Rarely, 3: Occasionally, 4: Frequently, 5: Always
Self-awareness and Resilience (SR)	Q1: How much has the intervention increased your awareness of your physical, emotional, and cognitive states?	1: Not at all, 2: To a small extent, 3: To a moderate extent, 4: To a large extent, 5: To a very large extent
	Q2: How confident do you feel in your ability to cope with stress after participating in the program?	1: Not confident, 2: Slightly confident, 3: Moderately confident, 4: Very confident, 5: Extremely confident
Social Responsibility Development (SRD)	Q1: To what extent has the program helped you understand societal issues and your role in addressing them?	1: Not at all, 2: To a small extent, 3: To a moderate extent, 4: To a large extent, 5: To a very large extent
	Q2: How likely are you to engage in community service or contribute to social causes based on what you have learned?	1: Not likely, 2: Slightly likely, 3: Moderately likely, 4: Very likely, 5: Extremely likely