P-ISSN: 2709-6254	Journal of Development and Social Sciences	April-June 2025, Vol. 6, No. 2
O-ISSN:2709-6262	https://doi.org/10.47205/jdss.2025(6-II)05	[42-52]

Journal of Development and Social Sciences
www.jdss.org.pk

RESEARCH PAPER

Understanding Environmental Science: Evaluating Conceptual understanding of Prospective Science Teachers for Environmental Issues in higher Education

[1]Tayyaba Muhammad Akram* and [2]Dr. Rizwan Akram Rana

1. PhD scholar, Department of Education, School of Social Science and Humanities, University of Management and Technology, Lahore, Punjab, Pakistan
2. Professor, Department of Education, School of Social Science and Humanities, University of Management and Technology, Lahore, Punjab, Pakistan

***Corresponding Author:** tayyaba.ier@pu.edu.pk

ABSTRACT

Present study aimed to evaluates the understanding of prospective science teachers at undergraduate level about the concepts of environmental science. Environmental science understanding among prospective teachers is essential and significant for the society to make sustainability parameters best in practice. For this purose, data were collected using Tayyaba Environmental Science Academic Performance Test (TEAT). A survey-based research design was employed, with purposive sampling of 54 prospective science students. The sample included prospective science teachers with background of pre-medical and pre-engineering, with a focus on overall conceptual understanding, Factors of environmental issues and the impact of demographic factors such as CGPA, study hours, socioeconomic status and internet usage. A 60-item MCQ-based assessment tool “Tayyaba Environmental Science Academic Performance Test (TEAT)” was designed to evaluate prospective science teachers’ conceptual understanding about environmental issues . Data were analyzed through Descriptive and inferential statistical methods. Results of descriptive statistics revealed that prospective science teachers achieved a moderate overall conceptual understanding (mean score = (M = 39.87, SD = 4.9), with significant variability across Factors. The highest mean score was observed in “Contribution of Environmental Sciences to Society” (M = 4.78, SD = 0.98), while the lowest was in “Human Environment and Resources” (M = 2.67, SD = 0.85). Inferential analyses showed no significant mean differences in conceptual understanding based on CGPA (F = 0.468, p = .798), study hours (F = 1.134, p = .355), socioeconomic status (F = 0.142, p = .868), or internet access (t = 1.15, p = .257). These findings highlight the importance of fostering environmental awareness and equipping future science teachers with the knowledge and skills to resolve environmental challenges. It is recommended that the short faculty training programs should be initiated to introduce experiential learning methods to teach science subjects like environmental sciences to strengthen compitesnes of teachers as well as students in improving conceptual understanding of Environmental issues to meet sustainable development goals (SDGS) in future.

KEYWORDS Conceptual Understanding, Environmental Issues, Prospective Science Teachers

Introduction

Now days, the natural environment is degrading due to the human activities, causing many environmental problems. Measures must be taken in time otherwise damage can be irreversible in the future. Primary, secondary and higher education play vital role in becoming the plate for environmental awareness. This can further facilitate to build sustainable society. Environmental sciences is an interdisciplinary field that integrates knowledge from biology, chemistry, physics, and social sciences. Environmental awareness through environmental sciences is a solution to meet Global challenges such as climate change, biodiversity loss, and resource depletion (Miller & Spoolman, 2021). Environmental crises emphasis on fostering environmental awareness and sustainable practices to new generation. Educational institutions of primary secondary and higher learning are responsible to equip students with the knowledge, skills, and values necessary to tackle these challenges and drive sustainable development (UNESCO, 2019).

Currently the Earth is dealing with some severe environmental issues such as pollution, global warming, deforestation and depletion of natural resources. All this degradation is due to human activities related to industrialization, urbanization and unsustainable agricultural practices (IPCC, 2023). These activities not only have been affecting ecosystems but also the economic stability, human health and social equity. Severe natural disasters such as hurricanes, floods and wildfires have been caused by climate change. These have irreversible impacts on communities, and ecosystems (IPCC, 2023). This can be related to the fact that environmental education is a very important tool in empowering individuals with the ability to comprehend these complex issues.

Environmental awareness and improvement of sustainability have crucial role of environmental education. Therefore, it offers people an understanding, skills and participation for informed decisions in undertaking environmental challenges (Muzaffar, 2016; Arshad et al., 2021). While integration of the subject environmental science at the curricula level, the universities are able to inculcate values such as environmental stewardship, problem solving skills, critical thinking and creativities thinking ability within the young generation (Rieckmann, 2012). Nevertheless, environmental education is effective only if teaching strategies are appropriate, students are engaged and there are resources (Lozano et al., 2013).

Current studies, on the other hand, have focused on the transformative aspect of environmental education for the purpose of cultivating environmental friendly attitudes and behaviors. Otto and Pensini (2017) also suggest that experiential learning and activities based on nature significantly increase students related knowledge about environment and commitment towards sustainability. Similarly, Ardoin et al. (2020) discussed how interdisciplinary instruction in environmental education help students link theory with reality by offering students the chance to link theoretical knowledge and actual application. Stern et al. (2022) showed just last year that embedding digital tools and gamification in environmental education leads to much higher student engagement and learning.

Despite resistance to some environmental education challenges such as curricula, training of teachers, use of teaching, strategies, it has inevitable importance in meeting Sustainable Development Goals (Brundiers & Wiek, 2013). Furthermore, climate change and biodiversity loss are complex environmental concepts that students struggle to grasp and that require a good knowledge of interdisciplinary knowledge (Heyl et al., 2013). In addition, demographic factors need to be explored further to determine whether it has an effect on students' conceptual understanding, in the context of prospective science teachers' learning of environmental science (Arshad et al., 2021).

An example of the disparities between access and quality of environmental education in advanced and undeveloped countries is a recent study conducted by Khan et al (2023) that focused on inclusive and equitable educational frameworks. Moreover, according to UNESCO's (2022) report, the call for increased fund in the area of teacher training and curriculum development to respond to increasing demand of Environmental Education in the midst of global environmental problems.

Literature Review

The environmental science is an interdisciplinary discipline that tries to determine the relationship between humans and their surroundings (Miller & Spoolman, 2021). That covers ecology, climate change, pollution, to sustainable development. It is critical for addressing global environmental challenges and encourage the practice of sustainability (IPCC, 2023). Environmental science is important because it offers holistic understanding of environmental issues and the resultant impacts of the latter on the human societies. On the other hand, emerging issues such as climate change are social and economic issues, whereby such issues impact food security, water availability as well as public health (IPCC, 2023). Additionally, biodiversity loss affects all levels of ecosystem, from the climate to the pollination, water purification and temperature regulation, all of which are important for human well being (Díaz et al., 2019).

Currently, environmental issues are linked together and require integrated solutions as recent research has suggested. In one such study by Rockström et al. (2023), it was observed that the planetary boundaries must be taken into account while aiming to develop in a sustainable manner to avoid irreversible damage to the environment. Also, the World Resources Institute (WRI, 2023) similarly stressed the urgent need to take action as a unified action to address climate change and biodiversity loss with the function of environmental science in providing evidence based solutions.

The Role of Education in Environmental Awareness

One of the ways to promote environmental awareness and positive sustainable behaviors is education (UNESCO, 2019). Environmental education makes the person knowledgeable, skilled and exemplary in regards to aiding in solving environmental issues and its contribution to sustainable development (Muzaffar, et. al., 2017; Arshad et al., 2021). In this process, universities, especially, have a significant role in this by adopting environmental science into their curriculums and also encourage research and innovation in sustainability (Lozano et al., 2013).

International Environmental Education Program was introduced in 1975 in all parts of the world as sustainability in education. Further, UNESCO in 2019 recognized that offering understanding and knowledge of sustainability through education is very significant for the 21st century society. Somewhat recently in 2019, UNESCO published the most refined frame work for the implementation of Education for Sustainable Development (ESD) to four groups, policies, learning environment, teachers/ educators, communities and youth. This was a step towards reaching the 17 Sustainable Development Goals upon the Agenda 2030 (Muzaffar, et. al., 2020; UNESCO, 2019).

In recent times, new ways to learn have been explored like, through using virtual reality (VR), and augmented reality (AR) to engage students in learning of complex environment concepts (Zhang et al., 2023). Moreover, according to Wals and Benavot (2023) in their study about cultural relevance and inclusivity in environmental education, they argue that the native knowledge and local perspectives should be incorporated into the curriculum (Muzaffar& Javaid, 2018).

Impact of Demographic Factors on conceptual understanding

The results as shown by Bozoglu et al. (2016) revealed that CGPA, study hours, socio economic status, socio technological access could have a strong impact on the prospective science teacher's conceptual understanding of science. For instance, students with high CGPA score and longer study duration get better results in courses of environmental science (Arshad et al., 2021). Similarly, learning is improved by also having access to smartphones and the internet, which can provide students with more resources as well as avenues for self – directed learning (Guo et al., 2020). The students that had the knowledge of environmental issues exhibited high level of environmental awareness, attitudes and behavior (Bozoglu et al., 2016). From the reseach it was inferred further for this is that the female stuents were more environmental awareness and showed better behavior.

After the extensive literature review it is conclusion that Environmental awareness and deep understanding of environmental issues is the research area and need of the hour for sustainability of any country. It is noticed that environmental sciences have been introduced by HEC Pakistan as compulsory for the students of undergraduate higher education. The purpose of present research study is to find out the understanding of university level science perspective teacher (undergraduate) about the environmental issue. Additionally, there is limited research on the impact of demographic factors on students' understanding of environmental science concepts (Arshad et al., 2021). This study aims to address these gaps by providing a comprehensive analysis of the respondents understanding about environmental issues.

Null Hypotheses (H_0)

H_{01}: There is no significant mean difference in overall conceptual understanding of prospective science teachers' with respect to different CGPA levels.

H_{02}: There is no significant mean difference in overall conceptual understanding of prospective science teachers' based on the number of study hours.

H_{03}: There is no significant mean difference in overall conceptual understanding of prospective science teachers' across different socioeconomic status groups.

H_{04}: There is no significant mean difference in overall conceptual understanding of prospective science teachers' with internet access and those without internet.

Material and Methods

Research Design

A survey-based research design was employed, Tayyaba Environmental Science Academic Performance' Test (TEAT) was administered to assess students' understanding of environmental science concepts. The study utilized purposive sampling to select 54 students from the 5th semester who had previously studied environmental science in their 2nd semester.

Sample and Demographics

The final sample consisted of 54 prospective Science teachers from BS Science Education program having medical and engineering back groud in FSC. The demographic characteristics of the participants are summarized below:

Table 1
Details of demographic distribution of the participation of prospective Science Teachers

Demographic Factor	Category	Frequency	Percentage
Discipline	Chemistry, Botany, Zoology	44	80.0%
	Physics, Mathematics A & B	10	20.0%
Previous Degree	F.Sc (Pre-Engineering)	10	20.0%
	F.Sc (Pre-Medical)	44	80.0%
CGPA	2.00-2.65	1	1.9%
	2.66-2.99	2	3.7%
	3.00-3.32	9	16.7%
	3.33-3.65	20	37%
	3.66-3.99	21	38.9%
	4.00	1	1.9%
Study Hours	1:30-2:00	6	11.1%
	2:00-2:30	12	22.2%
	2:30-3:00	9	16.7%

Demographic Factor	Category	Frequency	Percentage
	3:00-3:30	12.3	24.1%
	3:30-4:00	4	7.4%
	More than 4:00	10	18.5%
Socioeconomic Status	Low	03	5.6%
	Middle	46	85.2%
	High	5	9.3%
Smartphone Usage	Yes	53	98.1%
	No	1	1.9%
Internet Usage	Yes	52	96.3%
	No	2	3.7%

Instrument

A 60-item MCQ questionnaire "Tayyaba Environmental Science' Academic performance Test (TEAT)" was developed, covering ten key factors in environmental science:

1. Introduction to Environmental Sciences
2. Contribution of Environmental Sciences to Society
3. Human Environment and Resources
4. Different Aspects of Environment
5. Ecosystem and Major Components of Environment
6. Human Environment and its Problems
7. Biodiversity and Conservation
8. Development of Industrialization and Agricultural Growth
9. Environmental Challenges for Sustainable Development
10. Resources and Their Types

The questionnaire (Tayyaba Environmental Science' Academic performance Test (TEAT)) was developed to evaluate conceptual understanding of prospective science teachers. Each item was developed on the basis of above mentioned key factors, items scored as 1 for correct answer response, and scored as 0 for incorrect answer response.

Data Collection

Data were collected by researcher herself by taking the consent from adminsteration and class instructor. The time duration to solve the complete instrument was 90 minutes. The questionnaire was administered in a classroom environment to ensure uniform testing conditions. Data were collected anonymously to maintain confidentiality and to mitigate ethical research concerns.

Data Analysis

After data collection, data were analyzed through SPSS 21.0 version. Validity of the instrument was established; construct validity and face validity were established by expert educators and content validity was established by content experts. Relaibilty was determined as 0.812. Descriptive statistics (mean, standard deviation, and frequency distributions) were used to summarize student performance. Inferential statistics, including ANOVA and independent samples t-tests, were employed to compare performance based on demographic factors.

Ethical consideration

Before conducting the research, permission was requested from the Head of the Department. Consent form was taken from the group of prospective Science teachers who were the participants of the research study. Consent form was also taken by the course instructor to collect the data during the classroom conditions. The study is only for research purpose and data was kept confidential. Prospective teachers' personal information was not disclosed.

Results and Discussion

Descriptive Statistics

The overall conceptual understanding of prospective science teachers about environmental issues was assessed using the Tayyaba Environmental Science' Academic performance Test (TEAT). The results are summarized in table 2 and table 3.

Table 2
Descriptive Statistics of respondents 'overall conceptual understanding of prospective science teachers' in Environmental issues

Measure	Mean Score	Standard Deviation	Interpretation
Overall Performance (N=54)	39.87	4.9	Moderate performance with variability; some students scored significantly higher or lower than the mean.

The outcome of the descriptive analysis shows that the mean score prospective science teachers obtained in the Tayyaba Environmental Science' Academic performance Test (TEAT), was 39.87 of 60 which implies that prospective science teachers understood environmental issues to the moderate conceptual level. A value of 4.9 for the standard deviation indicates a large amount of variability among scores, since some students will score much higher or lower than the average. The variation of this metric might be caused by having differences in prior knowledge, study habits, or the engagement with the subject matter.

This moderate performance level concurs with findings of earlier studies such that students find it challenging to delve into the interdisciplinary and application based nature of environmental science (Miller & Spoolman, 2021). For instance, students are good at rooted themes such as Introduction to Environmental Sciences but struggle with the application of theoretical understanding of environmental science to the real world problems like Environmental Challenges for Sustainable Development (Ardoin et al., 2020). This highlights the importance of targeted intervention to fill the knowledge gaps and help students to relate the theory with practice. It also shows the uniqueness of student needs for learning based on the variability in scores. While some students may need remedial class or one-on-one tutoring for remedial classes, others may simply need to be pushed to grasp an idea. Rather than, high performing students may benefit from advanced coursework or research opportunities to develop their abilities and knowledge further. The descriptive statistics give the baseline understanding of students' conceptual understanding of prospective science teachers in the field of environmental science. While the somewhat moderate mean score indicates an opportunity to improve, the wide range of performance highlights that it is essential for personalized learning approaches to respond to the varying needs of prospective science teachers'. Hence, these results will be helpful for the further investigation of the variables that might influence performance in the section of inferential statistics.

Table 3
Descriptive Statistics of conceptual understanding of prospective science teachers' across 10 Factors in Environmental issues

Factor	Factors regarding Environmental issues	Mean	Standard Deviation
Factor 1	Introduction to Environmental Sciences	4.17	1.04
Factor 2	Contribution of Environmental Sciences to Society	4.78	0.98
Factor 3	Human Environment and Resources	2.67	0.85
Factor 4	Different Aspects of Environment	4.19	1.12

Factor 5	Ecosystem and Major Components of Environment	4.19	1.52
Factor 6	Human Environment and its Problems	4.54	1.18
Factor 7	Biodiversity and Conservation	4.15	1.25
Factor 8	Development of Industrialization and Agricultural Growth	3.28	0.76
Factor 9	Environmental Challenges for Sustainable Development	4.39	0.79
Factor 10	Resources and Their Types	3.54	0.69

Results from table No 3 showed that highest scoring factor is Factor 2 (Mean = 4.78/6), followed by Factor 6 and Factor 9 indicates students are strongest in these factors. Lowest Scoring Factors are Factor 3 (Mean = 2.67) and Factor 8 (Mean = 3.28). These factors may reflect conceptual difficulty or lack of instructional emphasis. Widest Variation found in Factor 5 (SD = 1.52), suggesting inconsistent understanding across students in that factor.

Inferential Statistics

Inferential statistics were used to test the hypotheses and address the research questions. The results are presented in table 4 to 7 with each table corresponding to a specific hypothesis.

Table 4
Mean difference in overall conceptual understanding of prospective science teachers' with respect to different CGPA levels

Variance	Sum of Squares	Means Square	Df	F	Sig.
Between Groups	58.654	11.731	5	0.468	0.798
Within Groups	1203.439	25.072	48		
Total	1262.093		53		

Table No 4 reveled that no significant differences were observed in conceptual understanding on CGPA. Therefore, H_{01} is accepted, suggesting that CGPA did not significantly influence conceptual understanding in results ($F = 4.468$, $p = 0.798$), accepting H_{01}.

Table 5
Mean difference in overall conceptual understanding of prospective science teachers' based on the number of study hours

Variance	Sum of Squares	Means Square	Df	F Value	Sig.
Between Groups	133.334	26.667	5	1.134	0.355
Within Groups	1128.758	23.516	48		
Total	1262.093		53		

Results from table 5 shows that the number of study hours did not significantly affect performance. Thus, H_{02} is accepted, indicating no statistical relationship between study hours and conceptual understanding. Students who studied for longer hours or less hours performed have no impact on understanding of environmental issues ($F = 1.134$, $p = 0.355$), accepting H_{02}. This highlights the importance of long term memory understanding of permanent change in academic success.

Table 6
Mean difference in overall conceptual understanding of prospective science teachers' across different socioeconomic status groups

Variance	Sum of Squares	Means Square	Df	F	Sig.
Between Groups	7.009	3.504	2	0.1420	0.868
Within Groups	1255.084	24.609	51		
Total	1262.093		53		

Results from table no 6 showed that Socioeconomic status did not show a statistically significant relationship with students' understanding. H_{03} is accepted. No significant differences were found based on socioeconomic status ($F = 0.1420$, $p = 0.868$), accepting H_{03}. Economic background does not significantly impact conceptual understanding of prospective science teachers about environmental science in this context.

Table 7
Mean difference in overall conceptual understanding of prospective science teachers' with internet access and those without internet

Variables	N	Mean	T	Sig.	Conclusion
Internet Users	52	42.1	1.15	0.257	Not significant difference ($p \geq 0.05$)
Non-Users	2	39.8			

Results from table No 7 reveled that Internet usage did not significantly impact students' conceptual understanding, leading to the accepted of H_{04}. No significant differences were found based on internet usage (t = 1.15, p =0.257), accepting H_{04}. Internet access alone does not significantly impact performance.

Discussion

The descriptive findings of this study indicate that prospective science teachers demonstrated moderate overall performance in understanding environmental science concepts (M = 39.87, SD = 4.9, out of a possible 60 points). This level of achievement suggests a basic familiarity with the subject, but also reflects gaps in deeper conceptual comprehension. The greatest strengths were observed in Factor 2: Contribution of Environmental Sciences to Society (M = 4.78, SD = 0.98) and Factor 6: Human Environment and Its Problems (M = 4.54, SD = 1.18). In contrast, the lowest scoring area was Factor 3: Human Environment and Resources (M = 2.67, SD = 0.85), indicating a potential conceptual difficulty or lack of instructional emphasis in this domain.

The inferential statistics revealed no significant differences in conceptual understanding based on students' CGPA (F = 0.468, p = .798), study hours (F = 1.134, p = .355), socioeconomic status (F = 0.142, p = .868), or internet access (t = 1.15, p = .257). These results indicate that students' academic backgrounds and access to resources did not meaningfully affect their understanding of environmental issues. This finding contrasts with prior assumptions that academic performance is closely tied to demographic variables, and instead highlights the central role of instructional quality, curriculum design, and active student engagement. Also it is essential to identify the standard deviation of some factors because it shows the variance or diversity in knowledge acquired by students, such as Factor 5: Ecosystem and Major Components of Environment, where SD = 1.52, which proves that students need to learn actively and engage in learning in order to make the gaps in their concepts less significant. Based on the research It is posited and argued from the literature that when it comes to EE, both experiential and interdisciplinary strategies (Ardoin et al., 2020; Stern et al., 2022) should be used.

Conclusion

The aim of this study was to assess the conceptual understanding of 54 prospective science teachers in environmental science using a 60 item TEAT test. The results revealed an average moderate performance (M = 39.87, SD= 4.9), and a great variety for the thematic area. Specific content areas where students need instructional reinforcement were highlighted by their performance, with Contribution of Environmental Sciences to Society (M = 4.78) being the strongest students performed and Human Environment and Resources (M = 2.67) being the weakest. Against expectation, CGPA (p = 0.798), study hours (p = 0.355), socioeconomic status (p = 0.868) and internet access (p = 0.257) were all statistically insignificant as far as they were concern with respect to students' performance. This suggests that achievement in environmental science is not as strongly related to background characteristics as it is to how it is taught and students' engagement with the content.

Recommandations

The study has implications for curriculum and pedagogy concerning the teaching of environmental science. Thus, the differences in the performance in the various themes suggest that the current curriculum may have weak competencies in dealing with the issues such as sustainability development and the conservation of biological diversity. To address this, the educators could complement the current more constructive and experiential forms of knowledge acquisition such as project-based learning, simulation and field trips into the curriculum of the students to aid their understanding of these concepts (Lozano et al., 2013). Besides, faculty training programs could be developed or existing programs could be effectively tailored in a way that would enable faculties to receive new strategies to teach activatively or through information technology given various learning requirement (Rieckmann, 2012).

References

Ardoin, N. M., Bowers, A. W., & Gaillard, E. (2020). Environmental education outcomes for conservation: A systematic review. *Biological Conservation, 241*, 108224.

Arshad, H. M., Khan, S., Ahmed, T., & Ali, R. (2021). Environmental awareness among university students: A case study from Pakistan. *Journal of Environmental Education, 52*(3), 123–135.

Bozoglu, M., Topuz, B. K., & Yilmaz, A. (2016). Environmental awareness and behavior among university students in Turkey. *Environmental Education Research, 22*(4), 567–582.

Brundiers, K., & Wiek, A. (2013). Do we teach what we preach? An international comparison of problem- and project-based learning courses in sustainability. *Sustainability, 5*(4), 1725–1746.

Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Guèze, M., Agard, J., Arneth, A., Balvanera, P., Brauman, K. A., Butchart, S. H. M., Chan, K. M. A., Garibaldi, L. A., Ichii, K., Liu, J., Subramanian, S. M., Midgley, G. F., Miloslavich, P., Molnár, Z., Obura, D., ... Zayas, C. N. (2019). *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES.

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). Sage.

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research, 102*, 101586.

Heyl, M., Moyano Díaz, E., & Cifuentes, L. (2013). Environmental attitudes and behaviors among university students in Chile. *Journal of Environmental Psychology, 36*, 1–10.

Intergovernmental Panel on Climate Change (IPCC). (2023). *Climate change 2023: The physical science basis*. Cambridge University Press.

Khan, S., Ahmed, T., Ali, R., & Arshad, H. M. (2023). Disparities in environmental education: A global perspective. *Journal of Environmental Studies, 45*(2), 234–250.

Lozano, R., Lukman, R., Lozano, F. J., Huisingh, D., & Lambrechts, W. (2013). Declarations for sustainability in higher education: Becoming better leaders through procedural and substantive approaches. *Sustainability, 5*(4), 1–20.

Miller, G. T., & Spoolman, S. (2021). *Environmental science*. Cengage Learning.

Muzaffar, M. (2016). *Educational Institutions and Political Awareness in Pakistan: A Case of Punjab*, Unpublished Ph. D Dissertation, International Islamic University Islamabad, Pakistan

Muzaffar, M., Hussain, B., Javaid, M. A., Khan, I. U., & Rahim, N. (2020). Political Awareness in Educational Policies of Pakistan: A Historical Review**,** *Journal of Political Studies, 27*(1), 257-273

Muzaffar, M. & Javaid, M. A. (2018). Curriculum and Political Socialization: a Case Study of Secondary Schools in Pakistan**,** *Journal of Political Science and International Relations, 4*(2), 21-31

Muzaffar, M., Javaid, M. A., & Sohail, F. (2017). Role of Pakistan Studies in Promoting Political Awareness at Secondary Level in Pakistan**,** *Bulletin of Education and Research, 39*(3), 57-74

Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change, 47*, 88–94.

Rieckmann, M. (2012). Future-oriented higher education: Which key competencies should be fostered through university teaching and learning? *Futures, 44*(2), 127–135.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., ... Foley, J. A. (2023). Planetary boundaries 3.0: A framework for global sustainability. *Nature Sustainability, 6*(1), 12–25.

Stern, M. J., Powell, R. B., & Hill, D. (2022). Digital tools and gamification in environmental education: Enhancing engagement and learning outcomes. *Environmental Education Research, 28*(5), 678–695.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2019). *Education for sustainable development: A roadmap*. UNESCO Publishing.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2022). *Global education monitoring report 2022: Education for people and planet*. UNESCO Publishing.

Wals, A. E. J., & Benavot, A. (2023). Indigenous knowledge and environmental education: Towards a more inclusive approach. *Sustainability Science, 18*(3), 567–580.

World Resources Institute (WRI). (2023). *State of the world's resources: Addressing climate change and biodiversity loss*. WRI.

Zhang, Y., Liu, J., & Wang, L. (2023). Virtual reality in environmental education: A systematic review. *Journal of Educational Technology & Society, 26*(2), 45–60.