Engagement in Grade 6 Science in Central Schools

NERISA G. BAUTISTA
Department of Education
Calbayog City Division, Calbayog City, Samar
nerisa.bautista1@deped.gov.ph

Abstract — This study determined the engagement in Science education among Grade 6 learners and teachers in the central schools of Calbayog City Division for the school year 2023-2024. The research assessed the level of engagement, identified challenges, and proposed an intervention program to enhance Science education. A descriptive assessment research design was employed, utilizing questionnaires to gather data from 301 Grade 6 learners and 12 Science teachers. The study revealed that learners exhibited strong engagement in science education, with cognitive engagement being the most prominent. Teachers, on the other hand, perceived high levels of engagement, with parental support being the most significant.

During the course of the study, no significant relationships were found between learners' engagement and their profile variables. However, teachers' engagement was positively associated with their educational attainment, position, length of service, and relevant trainings attended. In addition, the study identified resource constraints, student engagement, and time limitations as the main challenges faced by teachers. Based on the findings, the researchers proposed a comprehensive intervention program focusing on resource allocation, professional development, engaging learning experiences, and cross-disciplinary approaches to enhance science education engagement. The study concluded that addressing the identified challenges and implementing targeted interventions can significantly improve the engagement of Grade 6 learners and teachers in Science education within the Calbayog City Division.

Keywords — Science education, engagement, learners, teachers, intervention program, Calbayog City Division

I.   Introduction

Today's educational landscape's growing concern is the increasing academic demands placed on students across all grade levels. While academic rigor is valuable, the relationship between heightened scholastic demands and student behavior patterns has become a critical area of examination, particularly as educators observe changes in student responses to these elevated expectations. In fact, understanding this is essential for creating learning environments that promote both academic success and healthy social-emotional development. Teachers, for example, noticed a shift in what they were expected to teach and the standards for each grade level. It showed that the expectations of what was expected of student in all grades had become higher than before. For instance, Kindergarten is often compared to the new first grade pupils by teachers and parents. With the higher expectations, conversations on pushing students too much had been heightened and behaviors that possibly occurred due to those higher expectations prompted the question of what correlates with student behavior in the present academia.

A number of factors have led to poor student behavior. Students who have problems at home or whose parents were going through separation, for example, may be experiencing depression or stress that could lead to mood swings, declines in attentiveness, and impulsive behavior, all of which could be disruptive to the classroom (Ogundele, 2018). Students who lacked self-esteem may have misbehaved in an effort to resist participating in an activity that could lead to failure (Kessels & Heyder, 2020). For instance, if students thought they'll perform poorly on a test, they may have gone out of their way to avoid the test altogether. Physiological factors, including being hungry, tired, or sick, may have also led to disruptive classroom behavior. In this case, children may be inattentive, cranky, or otherwise difficult, which may have caused problems with their teachers or classmates while students with mental health challenges, such as anxiety disorder, may also act out in the classroom. They may throw tantrums, avoid certain activities, or melt down in response to the slightest criticism. Given these instances, educators needed to be mindful of this because students' behavior in school may not be consistent with their behavior at home. This is especially important in the event a teacher finds it necessary to schedule a call with a student's parent or guardian (Zolkoski & Lewis-Chiu, 2019).

Assessing the performance of the Philippine education system is a complex task owing to the magnitude of issues and challenges the sector is facing. One indicator of the country's state of basic education is the performance in the Programme for International Student Assessment (PISA) which showed dismal bottom ranking of the Philippines - 78/78 in 2018 and 77/81 in 2022. The Philippines was represented by a total of 7,193 students from 188 public and private schools. The total participating students represent the country's almost 1.8 million 15-year old students or 83 percent of the 15-year-old total population (PHD ASEAN, 2024). These low achievement levels are also documented in international assessments of science education. In the Trends in International Math and Science Study, Filipino grade 4 students ranked third from last out of 25 countries in science, with an average rating of 332. The average international rating was 489, and the highest rating by any country was 565. The grade 8 students ranked fourth from last out of 46 countries with an average rating of 377 in science. The average international rating was 474, and the highest rating by any country was 578. The TIMSS also showed that among grade 4 students, girls performed better than boys, but that this advantage of girls was no longer found in grade 8 (Tupas & Matsuura, 2019).

The current scenario presented above is an overview of what is the current scenario of student performance relative to the Science subject. As shown above, there is a need for immediacy to address what correlates this behavior as to resulting in such performance. It is in this context that the researcher is curious about the correlation of pupil behavior that may impact their learning, particularly in the Science subject with hopes that her study could be of help to better understand how students behave as to teaching of the Science subject.

The study then focused on the pivotal role of student engagement in shaping the effectiveness of the learning environment. It aimed to illuminate ways to enhance the current

educational setting, benefiting various stakeholders. For students, it offered insights into improving their learning experiences across subjects beyond Science, potentially bolstering their academic performance while teachers would gain awareness of areas for improvement in their teaching methods, enabling adjustments for better engagement and performance. Additionally, parents could also glean strategies to support their children's engagement in school, fostering a sense of involvement in their learning journey. Moreover, the study's outcomes hold promise as a valuable reference for researchers exploring engagement in Basic Science Education, expanding understanding and informing educational practices. In essence, this study's emphasis on student behavior stood to empower students, teachers, parents, and researchers alike. It further shed light on avenues for improvement in teaching methods, student involvement, and parental support, ultimately contributing to a more effective and enriching educational landscape across subjects and stakeholders.

This study is focused on the level of engagement in Science 6 among Grade 6 learners and Science teachers in Central Schools of Calbayog City for School Year 2023-2024 with the end view of developing a material program for Science 6 concepts. Specifically, it answered questions on the profile of the pupil-respondents in terms of age and sex as well as the profile of the teacher-respondents in terms of age, sex, civil status, highest educational attainment, and number of relevant trainings attended; assessed the level of engagement as perceived by the respondents themselves in terms of affective, behavior and cognitive as criteria variables; and identified problems encountered by the respondents on the correlates of pupil behavior in the teaching of science concepts.

The respondents of the study were limited to the Science 6 learners and Science teachers in the Central Schools of Calbayog City. Likewise, it made use of questionnaires as data gathering instruments. This study was conducted in Calbayog City during the School Year 2023-2024.

Literature Review

Learning Science at an early age is fundamental in ensuring that children understood life itself as well as the concepts necessary in its entirety. Science 6 is a complex stage wherein more advanced concepts were introduced to pupils and which is why they must be well engaged to have a better learning outcome. The researcher compiled literature and studies that gave deeper correlations with the study and the chosen variables of this study.

Conceptual Literature. Engaging students in Science and helping them develop an understanding of its ideas had been a consistent challenge for both Science teachers and Science educators alike. Such a challenge is even greater in the context of the "Science for All" curriculum initiative. Science as a school subject to be taught and learned, had always presented a challenge to both teachers and students (Hadzigeorgiou & Schulz, 2019). On the other hand, understanding Science, as a content, inquiry and process skill, had been a challenging task for students, as it involves a construction process, which is complex and iterative, not a linear one, and which also

took time and effort. An important implication of this construction process was the possibility for students to construct not only a conceptual framework that lacked the coherence of true scientific knowledge, but to equally construct alternative ideas different from the canonical scientific ones (Fulmer et al., 2019).

Another implication that was discovered was the construction process being influenced by several interrelated factors, such as students' prior conceptions and views on the nature of science, their interest and motivation, the classroom culture, the opportunities they have for social interaction, dialogue, and argumentation, the generation of representations, and for the use of modeling and analogies, and also their opportunities for cognitive dissonance and conceptual change, as well as for applying new knowledge to new contexts (Steidtmann et al., 2022). Knowing this concept, teaching Science was also considered a challenging task for teachers, because, in addition to providing students with opportunities for constructing scientific understanding, they had to primarily engage and motivate students with Science, its content and techniques (Caruana et al., 2020). Since it is obvious that without some degree of engagement, understanding could not truly take place even though some degree of understanding may very well motivate students to learn. With this, the initial engagement with Science seems to be a prerequisite for understanding and long-term learning. Needless to say, motivation on the part of students to learn does not guarantee an understanding of Science, especially Science content (Goldin-Meadow, 2016).

The problem of engaging students in Science, as mentioned, had always been challenging and pressing. Even though engagement did not necessarily entail, or result in, understanding, especially when it comes to the case of learning Science, engaging students became a prerequisite for understanding (Kerr, 2015). However, what may not be obvious was that the process of engagement itself was a complex one. Even though engagement may very well be encouraged by students' interest, there are other key factors which were also involved, such as personal identity, maturity, purpose for learning Science, and students' awareness of the significance of the object or topic of study. Such factors could influence a large extent, or may even determine, students' engagement with science (Knain et al., 2021).

Furthermore, the variety of ways in which the term "engagement" has been interpreted in the literature poses an additional problem in regards to the findings of the various studies on student engagement really mean (Longo, 2016). As Martin et al. (2020) pointed out, engagement has been construed as enjoyment and interest, but also as motivation toward Science, as well as future orientations toward Science. Moreover, it has been taken to mean the degree of students' participation in Science related activities, as well as intensity of such participation.

II. Methodology

Research Design

The study focused on the engagement in Science 6 among learners and teachers in central schools of the Schools Division of Calbayog City for School Year 2023-2024 utilized a descriptive assessment research design. As outlined by Dwivedi et al. (2023), this approach involves collecting, analyzing, and presenting data in an accessible manner, serving as a foundational research design. To comprehend the characteristics of the learner-respondents, their sex, socioeconomic status which includes their parents' highest educational attainment, parents' occupation, and gross monthly family income, and nutritional status were profiled. Concurrently, the teacher-respondents' profiles encompassed age, sex, civil status, highest educational attainment, position, length of service as science teachers, and number of relevant trainings attended. The study gauged the learner-respondent's perceptions of Science 6 engagement utilizing affective, behavioral, and cognitive criteria. While teacher-respondents gauged their perception of Science 6 engagement utilizing the following indicators: teacher support, peer support, and parental support. Furthermore, the research identified challenges encountered by the teachers on the correlates of learners' behavior in the teaching of Science 6 concepts.

Finally, the study investigated the relationship between the level of engagement of learners and teachers and their profile as well as the relationship between the level of engagement among the groups of respondents. Questionnaires served as the primary data collection instruments, while statistical analyses will be applied to interpret the acquired data comprehensively.

Sample of the Study

The study involved two distinct respondent groups: Science 6 learners and teachers. Their selection as respondents was based on their direct involvement and familiarity with the engagement level in Science 6. Table 1 presents the frequency and percentage distribution of the respondents from identified central school in the Schools Division of Calbayog City. The total number of respondents was 313, comprising 12 teachers and 301 learners. The teachers represented 3.99% of the total respondents, while the learners accounted for 96.01%.

The distribution of Grade 6 teachers varied across the central schools in the Schools Division of Calbayog City. Calbayog Pilot Central School and Calbayog East Central Elementary School had the highest number of teacher-respondents, each accounting for 2 or 16.70% of the total. Calbayog City SPED Center, San Policarpo Central Elementary School, Trinidad Central Elementary School, Oquendo Central Elementary School, Tarabucan Central Elementary School, Tinambacan Central School, San Joaquin Central Elementary School, and Malaga Central Elementary School each had 1 teacher-respondent, representing 8.30% of the total teacher-respondents.

Procedures

The data gathering process encompassed several systematic steps. Initially, the researcher will secure necessary permissions and clearances from relevant educational authorities, Schools Division of Calbayog City, and identified central schools within the division. Once permissions were granted, the researcher proceeded to develop structured questionnaires tailored separately for Science 6 learner- and teacher-respondents. These questionnaires were designed to capture diverse aspects related to engagement in science education, incorporating elements of affective, behavior, and cognitive criteria. Cluster sampling were employed for learner-respondents, aiming to cover various clusters within the district. All eligible Science 6 learners and teachers from selected schools were invited to participate.

Upon approval and coordination with school authorities, the researcher scheduled data collection sessions. Science 6 learners were briefed on the purpose and instructions for completing the questionnaire, ensuring clarity and understanding. The questionnaires were administered during appropriate class hours, and learners were given adequate time to respond comprehensively. Simultaneously, teacher-respondents were approached for complete enumeration, ensuring the inclusion of all science teachers teaching Grade 6 within the selected schools.

To maintain consistency and reliability, standardized instructions guided the administration of questionnaires to both learners and teachers. After completion, the collected data underwent meticulous scrutiny for accuracy and completeness. Data entry and coding processes were conducted to prepare the information for statistical analysis. Appropriate statistical measures and software tools were employed to analyze the gathered data, examining correlations, trends, and patterns related to the engagement levels in science education.

Once the data analysis phase concludes, the findings were meticulously interpreted, allowing for the generation of comprehensive insights and conclusions. These insights were presented through detailed reports, charts, graphs, and descriptive summaries. Additionally, the researcher ensured data confidentiality and anonymity, maintaining ethical standards throughout the entire data collection and analysis process.

Measures

The study utilized the Student Engagement in Schools Questionnaire (SESQ) and the Teacher Engagement Form-New (TERF-N) developed by Hart et al. (2011) as the main data collection instrument. The SESQ was specifically designed to comprehensively assess various dimensions of student engagement in school environments. It encompasses measures to gauge students' affective, behavioral, and cognitive engagement, providing insights into their interest, involvement, and perceptions toward learning. On the other hand, the Teacher Engagement Form-New (TERF-N) is a comprehensive instrument tailored to assess teacher engagement within educational settings. This questionnaire covers diverse aspects of teacher engagement, including their affective, behavioral, and cognitive engagement.

Both instruments were validated tools with established reliability ($\alpha = 0.83$), ensuring their credibility and accuracy in capturing nuanced aspects of engagement among students and teachers within the context of education (Buntins et al., 2021). The utilization of these instruments allowed for a comprehensive understanding of engagement levels, aiding in the derivation of valuable insights and conclusions for the study.

III. Results and Discussion

The salient findings of the study were summarized as follows:

1. The study revealed that the majority of Science 6 learners were female (50.17 percent), with most of their parents having attained at least a high school education. A significant proportion of both fathers (32.56 percent) and mothers (38.54 percent) were unemployed, and 43.52 percent of the learners' families had a gross monthly income of less than Php 10,000.00. The majority of the learners (90.70 percent) had a normal nutritional status.

2. The study found that most Science 6 teachers were male (58.33 percent), married (66.67 percent), and had earned master's units (75.00 percent). The majority held the position of Teacher I to III (75.00 percent), with 33.33 percent having 5 to 10 years of teaching experience. More than half of the teachers (58.33 percent) had attended 1 to 5 relevant trainings.

3. The learners exhibited a strong affective engagement in Science 6, with an overall weighted mean of 3.99 (Agree). They showed interest, enjoyment, pride, and happiness in learning science. The behavioral engagement was also positive, with an overall weighted mean of 3.83 (Agree), indicating active participation and effort in science classes. The cognitive engagement was the most prominent, with an overall weighted mean of 4.17 (Agree), suggesting the use of various cognitive strategies to understand and connect scientific concepts.

4. The study found no significant relationships between the learners' level of engagement in Science 6 and their profile variables, such as sex, parents' educational attainment, parents' occupation, gross monthly family income, and nutritional status. This suggests that these factors did not have a substantial impact on the learners' engagement in Science 6.

5. The teachers perceived a high level of engagement in Science 6 across the dimensions of teacher support (mean=3.99, Agree), peer support (mean=3.83, Agree), and parental support (mean=4.17, Agree). Parental support was found to be the most prominent, followed by teacher support and peer support.

6. The study revealed significant positive relationships between the teachers' level of engagement in Science 6 and their highest educational attainment, position, length of

service as science teachers, and the number of relevant trainings attended. This indicates that teachers with higher educational attainment, higher positions, longer teaching experience, and more relevant trainings tended to perceive higher levels of support for engaging students in Science 6.

7. The study found no significant relationship between the learners' and teachers' perceptions of engagement in Science 6, suggesting that their evaluations of engagement levels may differ or be influenced by different factors.

8. The most common challenges encountered by Science 6 teachers in teaching science concepts were related to resource constraints, student engagement, and time limitations. These challenges included the lack of resources or equipment for interactive learning experiences, limited hands-on experimentation opportunities, struggles in fostering students' intrinsic interest in scientific inquiry, and inadequate time allocation for in-depth exploration of scientific topics.This section is a comparative or descriptive analysis of the study based on the study results, previously literature, etc.

IV. Conclusion

Conclusion. Based on the salient findings, the following conclusions were drawn:

1. The majority of Science 6 learners in the central schools of the Calbayog City Division come from low-income families with unemployed parents, but most of them have a normal nutritional status.

2. The Science 6 teachers in these schools are predominantly male, married, and have earned master's units, with varying levels of teaching experience and relevant training.

3. The Science 6 learners demonstrate a strong engagement in science education across affective, behavioral, and cognitive dimensions, with cognitive engagement being the most prominent.

4. The learners' profile variables, such as sex, parents' educational attainment, parents' occupation, gross monthly family income, and nutritional status, do not significantly influence their engagement in Science 6.

5. The Grade 6 teachers perceive a high level of engagement in science education, with parental support being the most prominent, followed by teacher support and peer support.

6. Teachers with higher educational attainment, higher positions, longer teaching experience, and more relevant trainings tend to perceive higher levels of support for engaging students in Science 6.

7. The learners' and teachers' perceptions of engagement in Science 6 may differ or be influenced by different factors, as there is no significant relationship between their evaluations.

8. Science 6 teachers face various challenges in teaching science concepts, primarily related to resource constraints, student engagement, and time limitations, which may hinder the effective delivery of Science 6 concepts.

REFERENCES

[1] Adkins, D. G. (2020). Effects of Hands-On Experiences on Student Achievement, Interest, and Attitude in Chemistry [Dissertation]. Stephen F. Austin State University. https://scholarworks.sfasu.edu/cgi/viewcontent.cgi?article=1369&context=etds

[2] Bandura, A. (1978). Social Learning Theory. Contemporary Sociology, 7(1), 84. https://doi.org/10.2307/2065952

[3] Barnes, M., Gindidis, M., & Phillipson, S. (2018). Evidence-Based learning and teaching. In Routledge eBooks. https://doi.org/10.4324/9781351129367

[4] Berame, J. S. (2023). Level of technological implementation in science instruction to enhance National Achievement Test (NAT) performance in Butuan City Division, Philippines. American Journal of Education and Technology, 2(2), 124–133. https://doi.org/10.54536/ajet.v2i2.1639

[5] Berkes, F. (2017). Sacred Ecology. In Routledge eBooks. https://doi.org/10.4324/9781315114644

[6] Bilton, N., Rae, J., & Yunkaporta, T. (2020). A conversation about Indigenous pedagogy, neuroscience and material thinking. In Springer eBooks (pp. 85–97). https://doi.org/10.1007/978-981-15-7201-2_8

[7] Blades, D., & McIvor, O. (2017). Science education and Indigenous learners. In SensePublishers eBooks (pp. 465–478). https://doi.org/10.1007/978-94-6300-749-8_34

[8] Brigg, M. (2016). Engaging Indigenous knowledges: from sovereign to relational knowers. The Australian Journal of Indigenous Education, 45(2), 152–158. https://doi.org/10.1017/jie.2016.5

[9] Buntins, K., Kerres, M., & Heinemann, A. (2021). A scoping review of research instruments for measuring student engagement: In need for convergence. International Journal of Educational Research Open, 2, 100099. https://doi.org/10.1016/j.ijedro.2021.100099

[10] Caruana, D. J., Salzmann, C. G., & Sella, A. (2020). Practical science at home in a pandemic world. Nature Chemistry, 12(9), 780–783. https://doi.org/10.1038/s41557-020-0543-z

[11] Cents-Boonstra, M., Lichtwarck-Aschoff, A., Denessen, E., Aelterman, N., & Haerens, L. (2020). Fostering student engagement with motivating teaching: an observation study of teacher and student behaviours. Research Papers in Education, 36(6), 754–779. https://doi.org/10.1080/02671522.2020.1767184

[12] Cirkony, C., & Kenny, J. (2022). Using formative assessment to build coherence between educational policy and classroom practice: A case study using Inquiry in Science. Australian Journal of Teacher Education, 47(10), 77–105. https://doi.org/10.14221/ajte.2022v47n10.5

[13] Cirkony, C., Tytler, R., & Hubber, P. (2022). Designing and delivering representation-focused science lessons in a digital learning environment. Educational Technology Research and Development, 70(3), 881–908. https://doi.org/10.1007/s11423-022-10094-z

[14] Dayagbil, F. T., Palompon, D. R., Garcia, L. L., & Olvido, M. M. J. (2021). Teaching and learning continuity amid and beyond the pandemic. Frontiers in Education, 6. https://doi.org/10.3389/feduc.2021.678692

[15] DeVito, M. (2016). Factors Influencing Student Engagement [Thesis]. Sacred Heart University.
https://digitalcommons.sacredheart.edu/cgi/viewcontent.cgi?article=1010&context=edl

[16] Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., . . . Wright, R. (2023). Opinion Paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. International Journal of Information Management, 71, 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642

[17] Eberbach, C., & Hmelo-Silver, C. E. (2015). Inquiry, learning through. In Springer eBooks (pp. 514–516). https://doi.org/10.1007/978-94-007-2150-0_192

[18] Fulmer, G. W., Ma, H., & Liang, L. L. (2019). Middle school student attitudes toward science, and their relationships with instructional practices: a survey of Chinese students' preferred versus actual instruction. Asia-Pacific Science Education, 5(1). https://doi.org/10.1186/s41029-019-0037-8

[19] Gaines, E. S. (2021). Teacher Perceptions of Teaching Science Using the 5E Instructional Model [Dissertation, Columbus State University]. https://csuepress.columbusstate.edu/cgi/viewcontent.cgi?article=1447&context=theses_dissertations

[20] Goldin-Meadow, S. (2016). Using our hands to change our minds. WIREs Cognitive Science, 8(1–2). https://doi.org/10.1002/wcs.1368

[21] Gowmon, V., & Bradley, A. (2014). Let the Fire Burn: Nurturing the Creative Spirit of Children. Vince Gowmon.

[22] Grove, A. (2019). The Teacher's Role in Student Engagement [Dissertation, Gardner-Webb University]. https://digitalcommons.gardner-webb.edu/cgi/viewcontent.cgi?article=1352&context=education_etd

[23] Hadzigeorgiou, Y., & Schulz, R. M. (2019). Engaging Students in Science: The potential role of "Narrative Thinking" and "Romantic Understanding." Frontiers in Education, 4. https://doi.org/10.3389/feduc.2019.00038

[24] Hall, L. J., Dell, C. A., Fornssler, B., Hopkins, C. A., Mushquash, C., & Rowan, M. (2015). Research as Cultural Renewal: Applying Two-Eyed Seeing in a Research Project about Cultural Interventions in First Nations Addictions Treatment. International Indigenous Policy Journal, 6(2). https://doi.org/10.18584/iipj.2015.6.2.4

[25] Han, H., & Ahn, S. W. (2020). Youth Mobilization to Stop Global climate Change: Narratives and impact. Sustainability, 12(10), 4127. https://doi.org/10.3390/su12104127

[26] Hart, S. R., Stewart, K., & Jimerson, S. R. (2011). The Student Engagement in Schools Questionnaire (SESQ) and the Teacher Engagement Report Form-New (TERF-N): examining the preliminary evidence. Contemporary School Psychology, 15(1), 67–79. https://doi.org/10.1007/bf03340964

[27] Heilporn, G., Lakhal, S., & Bélisle, M. (2021). An examination of teachers' strategies to foster student engagement in blended learning in higher education. International Journal of Educational Technology in Higher Education, 18(1). https://doi.org/10.1186/s41239-021-00260-3

[28] Hobbs, L., Jones, M., Kenny, J., Campbell, C., Chittleborough, G., Herbert, S., Gilbert, A., & Redman, C. (2016). Successful university-school partnerships: An interpretive framework to inform partnership practice. Teaching and Teacher Education, 60, 108–120. https://doi.org/10.1016/j.tate.2016.08.006

[29] Hollister, B., Nair, P., Hill-Lindsay, S., & Chukoskie, L. (2022). Engagement in Online Learning: Student attitudes and behavior during COVID-19. Frontiers in Education, 7. https://doi.org/10.3389/feduc.2022.851019

[30] Kayumova, S., & Dou, R. (2022). Equity and justice in science education: Toward a pluriverse of multiple identities and onto-epistemologies. Science Education, 106(5), 1097–1117. https://doi.org/10.1002/sce.21750

[31] Kenny, J., & Cirkony, C. (2022). Using a systems perspective to develop underlying principles for systemic educational reform. Australian Journal of Teacher Education, 47(1), 80–99. https://doi.org/10.14221/ajte.2022v47n1.6

[32] Kenny, J., Jones, M., & Speldewinde, C. (2018). Theory and Practice: The context of Partnerships in Teacher Education. In Springer eBooks (pp. 3–19). https://doi.org/10.1007/978-981-13-1795-8_1

[33] Kerr, P. H. (2015). Adaptive learning: ELT Journal, 70(1), 88–93. https://doi.org/10.1093/elt/ccv055

[34] Kessels, U., & Heyder, A. (2020). Not stupid, but lazy? Psychological benefits of disruptive classroom behavior from an attributional perspective. Social Psychology of Education, 23(3), 583–613. https://doi.org/10.1007/s11218-020-09550-6

[35] Klopfer, L. E., & Aikenhead, G. S. (2022). Humanistic science education: The history of science and other relevant contexts. Science Education, 106(3), 490–504. https://doi.org/10.1002/sce.21700

[36] Knain, E., Fredlund, T., & Furberg, A. (2021). Exploring student reasoning and representation construction in school science through the lenses of social semiotics and interaction analysis. Research in Science Education, 51(1), 93–111. https://doi.org/10.1007/s11165-020-09975-1

[37] Kutz, S., & Tomaselli, M. (2019). "Two-eyed seeing" supports wildlife health. Science, 364(6446), 1135–1137. https://doi.org/10.1126/science.aau6170

[38] Lo, C. K., & Hew, K. F. (2018). A comparison of flipped learning with gamification, traditional learning, and online independent study: the effects on students' mathematics achievement and cognitive engagement. Interactive Learning Environments, 28(4), 464–481. https://doi.org/10.1080/10494820.2018.1541910

[39] Longo, C. M. (2016). Changing the instructional model: Utilizing blended learning as a tool of inquiry instruction in middle school science. Middle School Journal, 47(3), 33–40. https://doi.org/10.1080/00940771.2016.1135098

[40] Mafi, M. (2022). NGSS-Based Pedagogies: One Secondary Education Teacher's Approach to Developing Student's Science Identities [Thesis]. University of New Mexico - Main Campus. https://digitalrepository.unm.edu/cgi/viewcontent.cgi?article=1338&context=educ_teelp_etds

[41] Martin, F., Chen, Y., Moore, R. L., & Westine, C. D. (2020). Systematic review of adaptive learning research designs, context, strategies, and technologies from 2009 to 2018. Educational Technology Research and Development, 68(4), 1903–1929. https://doi.org/10.1007/s11423-020-09793-2

[42] Michelene, T. H., & Wylie, R. (2014). The ICAP Framework: Linking Cognitive engagement to active learning Outcomes. Educational Psychologist, 49(4), 219–243. https://doi.org/10.1080/00461520.2014.965823

[43] Moran, E. (2022). The Role of Science in Elementary Education [Thesis]. Dominican University of California. https://doi.org/10.33015/dominican.edu/2022.EDU.04

[44] Ogundele, M. (2018). Behavioural and emotional disorders in childhood: A brief overview for paediatricians. World Journal of Clinical Pediatrics, 7(1), 9–26. https://doi.org/10.5409/wjcp.v7.i1.9

[45] Ottenbaker, D. (2022). Secondary Science Classrooms Are Not Engaging Enough to Draw Marginalized Students into STEM Courses [Thesis]. Grand Valley State University. https://scholarworks.gvsu.edu/cgi/viewcontent.cgi?article=1197&context=gradprojects

[46] Palines, K. M. E., & Cruz, R. a. O. (2021). Facilitating factors of scientific literacy skills development among junior high school students. LUMAT, 9(1). https://doi.org/10.31129/lumat.9.1.1520

[47] Panjaburee, P., & Srisawasdi, N. (2016). An integrated learning styles and scientific investigation-based personalized web approach: a result on conceptual learning achievements and perceptions of high school students. Journal of Computers in Education, 3(3), 253–272. https://doi.org/10.1007/s40692-016-0066-1

[48] Price, R. (2022). A Causal-Comparative Study: The Effects of School Type and School Climate on Mathematical Achievement [Dissertation]. Liberty University. https://digitalcommons.liberty.edu/cgi/viewcontent.cgi?article=4798&context=doctoral

[49] Robinson, K., & Mueller, A. S. (2014). Behavioral Engagement in Learning and Math Achievement over Kindergarten: A Contextual Analysis. American Journal of Education, 120(3), 325–349. https://doi.org/10.1086/675530

[50] Rudovic, O., Lee, J., Dai, M., Schuller, B., & Picard, R. W. (2018). Personalized machine learning for robot perception of affect and engagement in autism therapy. Science Robotics, 3(19). https://doi.org/10.1126/scirobotics.aao6760

[51] Smiderle, R., Rigo, S. J., Marques, L. B., De Miranda Coelho, J. a. P., & Jaques, P. A. (2020). The impact of gamification on students' learning, engagement and behavior based on their personality traits. Smart Learning Environments, 7(1). https://doi.org/10.1186/s40561-019-0098-x

[52] Steidtmann, L., Kleickmann, T., & Steffensky, M. (2022). Declining interest in science in lower secondary school classes: Quasi-experimental and longitudinal evidence on the role of teaching and teaching quality. Journal of Research in Science Teaching, 60(1), 164–195. https://doi.org/10.1002/tea.21794

[53] Stephenson, R. L. (2017). Elementary Teachers' Perceptions of Teaching Science to Improve Student Content Knowledge [Dissertation]. Walden University. https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=4943&context=dissertations

[54] Swan, P. (2022). Citizen Science As Experiential Education In The Modern Classroom [Capstone Project]. Hamline University. https://digitalcommons.hamline.edu/cgi/viewcontent.cgi?article=1875&context=hse_cp

[55] Taherdoost, H. (2016). Sampling methods in research methodology; How to choose a sampling technique for research. Social Science Research Network. https://doi.org/10.2139/ssrn.3205035

[56] Tang, K., Won, M., & Treagust, D. F. (2019). Analytical framework for student-generated drawings. International Journal of Science Education, 41(16), 2296–2322. https://doi.org/10.1080/09500693.2019.1672906

[57] Taylor, C. (2022). Phenomenon-Based Instruction in the Elementary Classroom: Impact on Student Engagement and Achievement in Science Content Learning [Dissertation]. Boise State University. https://scholarworks.boisestate.edu/cgi/viewcontent.cgi?article=3089&context=td

[58] Tupas, F. P., & Matsuura, T. (2019). Moving forward in STEM education, challenges and innovations in senior high school in the Philippines: the case of northern Iloilo Polytechnic State College. Jurnal Pendidikan IPA Indonesia, 8(3). https://doi.org/10.15294/jpii.v8i3.19707

[59] Wilson, R., & Bradbury, L. (2021). Assessing early primary students' growth in a science unit using multiple modes of representation: investigating the promise of explicit drawing instruction. International Journal of Science Education, 43(8), 1341–1364. https://doi.org/10.1080/09500693.2021.1909774

[60] Xu, L., Prain, V., & Speldewinde, C. (2021). Challenges in designing and assessing student interdisciplinary learning of optics using a representation construction approach. International Journal of Science Education, 43(6), 844–867. https://doi.org/10.1080/09500693.2021.1889070

[61] Zheng, J. (2021). A functional review of research on clarity, immediacy, and credibility of teachers and their impacts on motivation and engagement of students. Frontiers in Psychology, 12. https://doi.org/10.3389/fpsyg.2021.712419

[62] Zolkoski, S. M., & Lewis-Chiu, C. G. (2019). Alternative approaches: Implementing mindfulness practices in the classroom to improve challenging behaviors. Beyond Behavior, 28(1), 46–54. https://doi.org/10.1177/1074295619832943