

Differentiated instruction based on multiple intelligences as promising joyful and meaningful learning

Subuh Anggoro¹, Azmi Fitriati², Ng Khar Thoe³, Corrienna Abdul Talib⁴, Lia Mareza¹

¹Elementary Teacher Education Department, Universitas Muhammadiyah Purwokerto, Purwokerto, Indonesia

²Accounting Department, Universitas Muhammadiyah Purwokerto, Purwokerto, Indonesia

³Faculty of Social Science and Liberal Arts, UCSI University, Kuala Lumpur, Malaysia

⁴Educational Science, Mathematics and Creative Multimedia Department, School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, Skudai, Malaysia

Article Info

Article history:

Received Dec 12, 2022

Revised Oct 3, 2023

Accepted Oct 20, 2023

Keywords:

Differentiated instruction

Elementary school

Joyful

Meaningful

Multiple intelligences

ABSTRACT

Boredom has previously been linked to negative academic outcomes such as academic motivation, strategies, and achievement. The understanding of multiple intelligence approaches creates opportunities for all learners to develop their potential to optimize learning through differentiated instructions. This research aims: i) to design and to develop differentiated instruction based on learners' multiple intelligences for elementary schools; and ii) to measure the effectivity of students' learning attitude and mastery of concepts. Using design and development research (DDR) anchored on analysis, development, design, implementation, and evaluation (ADDIE) model and quasi-experimental research, the differentiated instruction based on multiple intelligence was conducted in a private Islamic Elementary School in collaboration with 3 class teachers. Based on the results of observations conducted at the school, the findings revealed that the learners can maximize their logical-mathematical, language, kinesthetic, interpersonal, and intrapersonal intelligences through a differentiated instruction based on multiple intelligence approach. Students experienced a joyful and meaningful learning atmosphere; hence it was expected that their intelligences can be developed naturally. In addition, this instruction was found to be effective to enhance science concept mastery especially in the aspects of remembering, understanding, and applying. The differentiated instruction based on multiple intelligences should be developed further to examine the effectiveness of the model in thematic learning for students both with low and high achievement.

This is an open access article under the [CC BY-SA](#) license.



Corresponding Author:

Subuh Anggoro

Elementary Teacher Education Department, Universitas Muhammadiyah Purwokerto

Jalan KH Ahmad Dahlan, 53182 Banyumas, Central Java, Indonesia

Email: subuhanggoro@ump.ac.id

1. INTRODUCTION

Students frequently complain about boredom. Boredom has previously been linked to negative academic outcomes such as academic motivation, strategies, and achievement [1]–[4] that was also among the important factors leading to dropout as reported by Durairaj *et al.* [5]. It is important to comprehend students' in-class boredom, particularly factors that may make worse [6]. This was due to the fact that the material taught was significantly disassociated from their daily experiences [7], [8]. They learn by memorizing a lot of concepts, so they do not understand and then cannot apply the concept(s) in the real world [9]. Learning is a process, not a product, and it can be accelerated or improved through social and group processes [10], [11].

The use of the 'one-size-fits-all' curriculum does not meet the needs of students to get a fun and meaningful learning [11]–[13]. Besides that, it is a well known fact that students actually have individual multiple intelligences and diverse styles of learning [14]–[16]. Hence, this study was conducted to show how 'differentiated instruction based on multiple intelligences could serve as promising joyful and meaningful learning in an elementary school. The brain-based learning process seeks to utilize the brain to process, to store, and to retrieve information maximally [17]–[19]. Based on imaging studies nerves in the amygdala, hippocampus, and parts of the limbic system, learners' comfort level has an important impact on the transmission and storage of information in the brain [20]. This affects the states of mind necessary for successful learning, remembering and higher order thinking [20]–[22].

Using learning models based on multiple intelligences and learning styles, students could be guided to explore important concepts. This can also be used as the information about their respective ability [10], [12], [23]. In the inclusion class, differentiated instruction is an important factor for success of delivery of lessons. So, this type of instruction should be included in schools with students of diverse needs, achievement levels, interests, and learning styles. Instruction should also be differentiated to take advantage of, rather than to ignore the diversity [23], [24].

To be able to apply differentiated instruction, teacher must make modifications to the learning content to be delivered and prepare the necessary processes and devices [25]–[27]. Teachers need to be equipped with an understanding of the modalities of students [28], [29]. The purposes of this research are: i) to create differentiated instruction that can reduce classroom boredom; ii) to measure the effectivity of instruction in promoting e students' science concept mastery. The novelty of this research is developing and implementing a design of instructional systems namely differentiated instruction for thematic science based on joyful learning and multiple intelligences. This learning design is equipped with preferred activities multiple intelligence and learning style and observed of joyful indicators activities.

2. RESEARCH METHOD

This study integrate the design and development research (DDR) method with Specific Project Phases for example analysis, design, development, implementation and evaluation (ADDIE) model with research problems identified based on reviews of literature to fill gaps with instructional design knowledge base [30]. To answer the first research purpose, the research design used in this study is DDR a research and development (RnD) method. The stages in this study refer to the ADDIE model as aforementioned. These stages consist of: i) needs analysis; ii) designing differentiated instruction based on multiple intelligences and learning styles; iii) developing and validating instructional materials and instruments; iv) implementing it on three classes in one school; and v) creating e a revised instruction based on the test results during evaluation stage.

To answer the second purpose, quasi-experiment was used as research method with nonequivalent pretest posttest design [31]. The participants were 77 students of the fourth grade in a private elementary school. There are three variables in this study, namely the 'differentiated instruction' as the independent variable, and 'the learning attitude and concept mastery' as the dependent variables. The conceptual mastery indicators used in this study are based on Bloom's cognitive domain levels, which are limited to remembering (C1), understanding (C2), applying (C3), and analyzing (C4) [32], [33]. A good instrument is required in this study to obtain accurate data. The test items were validated by a team of experts who specialized in technology and environment, elementary school physics, and learning assessment before being used in research. validated instruments were then tested using Anates software to determine their level of difficulty, validity, and reliability.

The second objective of this study was to compare as well as to differentiate the experimental and control groups' increases in terms of students; concept mastery. The purpose of this test was to see if there were any differences in the increase of it before and after treatment. The gain index (N-Gain) can be used to calculate the increase that occurs before and after learning [34]. Then, t-test analysis was used to examine the influence of differentiated instruction on the concept mastery.

3. RESULTS AND DISCUSSION

Differentiated instruction as a design of instructional systems is a systematic method of developing educational and training programs to improve students' performance. There are five steps in the instructional system design (ISD) process: analysis, development, design, implementation, and evaluation (ADDIE). The instructional development steps are described.

3.1. Need analysis

Attributes of multiple intelligences were used as tools and as solving problems in learning [35], [36]. Multiple intelligences create opportunities for all students to develop their potential through differentiated instruction and various assessments. The teacher delivered lessons and evaluations using differentiated instructions and varied assessments [25], [37]–[41]. The learning process that accommodates the diverse learning needs of students is done by varying the methods and materials used to teach each concepts that were considered greatly important [10], [41], [42].

Differentiated instruction, as a teaching philosophy, is based on the premise that students learn best when their teachers accommodate differences based on their level of readiness, interest, and learning profile [42], [43]. The main goal of differentiated instruction is to maximize each student's ability to learn [10], [24]. In addition, differentiated instruction can be done in various ways. If the teachers are willing to use this philosophy in their classrooms, they will choose more types of effective learning strategies based on the uniqueness of diverse learners [9], [44]–[46].

Differentiated instruction is not only a type of learning strategy nor a recipe for teaching, but it is an innovative approach to teaching and learning [45]–[48]. The main principle of Vygotsky's socio-cultural theory is the social and interactional relationship between teachers and students [48], [49]. This instruction, which supports multiple intelligences and various learning styles students in class, provides an effective means of dealing with diversity of the ability of learners [39], [48], [50]–[52].

All inclusive classroom teachers need differentiated instruction in order to provide all students equal opportunities for success [46], [53]. Different classrooms balance the demands of all students, with more specific needs characterized by respecting individual learners [45], [54], [55]. Differentiated instruction offers opportunities for individual learners to do their best [56], [57].

Differentiated instruction 'forces' teachers to change their minds from simply finishing curriculum to moving closer to meeting the individual needs of learners [41], [42], [45], [58]. This allows the teacher to remain focused on the most important principles that all students must master despite the fact that each student's understanding of a subject develops at a different rate [41]. Each student must meet minimum completeness so that they need to study as quickly and deeply as possible [23], [59].

3.2. Design and develop

Design and manufacturing or development of differentiated instructions is based on multiple intelligences and learning style. The learning process starts from preliminary activities (apperception), continued by this activity, and ended by a closing activity. One form of learning implementation plan (LIP) that uses differentiated instruction based on the developed and validated multiple intelligences and learning styles student is attached in Appendix.

3.3. Implementation

The model was developed at a private Islamic school. Three teachers were selected as model teachers. Based on the results of the discussion, it was agreed that the theme for the learning model is my aspirations and our living environment. Ratih Widyaningrum became a model teacher with the theme of 'My Dreams' Figures 1 and 2 including science thematic content on the concept of sound. Meanwhile, Irma Nurlaeli as model teacher for the theme of 'My Dream Jobs' with science content on the concept of sound propagation. Then, Sri Mulyati become a model teacher for the environmental theme of 'Our Friends' as presented in Figure 3 with the science content about erosion.



Figure 1. Model teachers for 'My dream' theme



Figure 2. Model teachers for 'My dream jobs' theme



Figure 3. Model teacher for the environmental theme of 'Our friends'

The learning activities were carried out by the model teachers. They have tried to benefit the knowledge of students' multiple intelligences such as interpersonal intelligence, intrapersonal, logical-mathematical, language and kinesthetic. The learning activities based multiple intelligences can be seen in Figures 4 to 7.



Figure 4. Intrapersonal intelligence



Figure 5. Interpersonal intelligence



Figure 6. Kinesthetic intelligence



Figure 7. Logical and language intelligence

3.4. Evaluation

Based on the observation of the activities by teacher and students, it was revealed that there was a good interaction between the two in utilizing the students' multiple intelligences. Students can develop their modalities freely without feeling pressured. The learning process accommodates the students' diverse learning needs by varying the methods and materials used to teach each greatly important concept [20], [41], [42], [58].

Differentiated instruction as a philosophy of teaching is based on the premise that when their teachers accommodate the differences of their level of readiness, interest and learning profile, students will learn best [26], [28]. In the core learning activity for the 'My dreams' theme, students make a stethoscope Figure 8, a tool to check heart rate or internal organs, using equipment assembled by students in groups. Through these activities, interpersonal intelligence, logical-mathematical, language, kinesthetic, were developed naturally.



Figure 8. Steps for making and using a stethoscope

Differentiated instruction can be done in various ways. If the teachers are willing to use this philosophy in their classrooms [44], [46], [60], they will choose more types of effective learning strategies based on the uniqueness of diverse learners [9], [60]. So, differentiated instruction is neither only a learning strategy nor a recipe for teaching. It is an innovative way of thinking about teaching and learning [42], [46]–[48]. The main principle of this instruction, which is in line with Vygotsky's socio-cultural theory include the social and interactional relationship between teachers and students. This instruction also provides an effective means of dealing with diversity of ability among learners, which supports students with multiple intelligences and various learning styles in class [51], [52].

All inclusive classroom teachers needs differentiated instruction in order to create opportunities for success for all students [46], [52]. There are balance learning needs for all students, with more specific needs characterized by respecting each student [45], [54], [55], [61]. Differentiated instruction offers opportunities for students individually to do their best [56], [57]. This instruction also 'force' teachers to change their mindset from only completing the curriculum, to moving closer to meeting the individual needs of learners [41], [42], [45]. Thus, the teacher should focus on the key principles that must be mastered by all students by considering the speed of the learning process for better understanding of concepts in a variety of ways [50]. Each student must meet minimum completeness so that they need to study as quickly and deeply as possible [23], [41], [59]. The teacher who uses differentiated instruction, finds that student can use time and resources flexibly and creatively, thus helping to create an atmosphere of collaboration in the classroom [27], [40]. So, differentiated instruction can be a more interesting experience for teacher because it involves a different type of energy compared to direct instruction.

3.5. The effectiveness of differentiated instruction to science concept mastery

According to Bloom's taxonomy which has been revised by Anderson and Krathwohl, conceptual understanding can be defined as factual knowledge, while concept mastery is termed as conceptual knowledge [31]. Factual knowledge refers to a collection of information (terms and facts), while conceptual knowledge is more widely defined with more organized body of knowledge (including concepts, principles, models or theories). The ability of students to understand the concept of the relationship among natural resources and the environment, technology, and society at the cognitive level of remembering (C1), understanding (C2), applying (C3), and analyzing (C4) is defined as mastery of the concept as observed in this study. The results of the pretest, posttest, and N-Gain during treatment are shown in Figure 9.

According to Figure 9, the majority of students in the control class had a low N-Gain score. There were differences in the students' cognitive level of remembering, understanding, and doing in the experimental class. Due to the concept of knowing, understanding, and applying more concepts than the control class, which had a lower percentage of rise in concept mastery, the percentage of students in the experimental class with an increase in concept mastery was higher. Based on these findings, it is possible to conclude that the differentiated instruction in learning science provides mastery of concepts better than conventional learning. This is consistent with the findings of researches [29], [62], [63], which found that this instruction produces better learning outcomes than traditional learning methods.

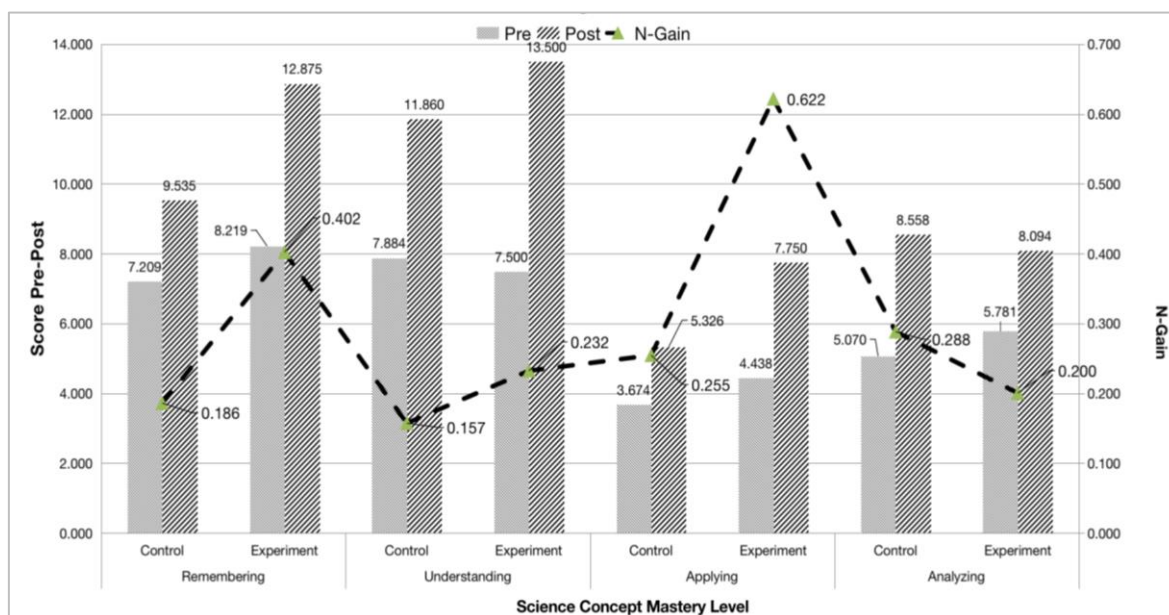


Figure 9. The illustration on the descriptive statistics of the effectiveness of differentiated instruction on science concept mastery level

As presented in Table 1, students are more likely to remember and understand what they have learnt if it is interesting or forces them to solve a problem on their own. When student's interest is high, their stress and boredom will automatically decrease, allowing students to accept their mistakes and then to try again. The more focused the students are, the easier it will be for them to comprehend the material the teacher provides [15], [59].

Table 1. The test difference of average N-gain concept mastery level

Concept mastery level	Group	Mean	Std. Dev.	Mean difference	Std. error difference	T	df	p
Remembering	1. Experiment	0.403	0.222	0.220	0.044	5.053	75	0.000
	2. Control	0.183	0.153					
Understanding	1. Experiment	0.232	0.137	0.079	0.029	2.755	75	0.000
	2. Control	0.153	0.109					
Applying	1. Experiment	0.552	0.326	0.323	0.060	5.392	75	0.000
	2. Control	0.229	0.184					
Analyzing	1. Experiment	0.200	0.160	-0.087	0.040	-2.193	75	0.032
	2. Control	0.287	0.176					

Students will be stressed if their lessons are boring, irrelevant to their lives, or confusing [20], [64]. Under these circumstances, information cannot be passed through the amygdala to a higher level of thinking or the brain's memory center [22], [65]. New information cannot be processed, linked to previous knowledge, and stored for later recall in the brain.

There is an anomaly of the cognitive mastery level of analyzing. For fourth-grade students, the ability to analyze is a challenge. According to Piaget, they are still developing concrete operational stage in their cognitive development [66], [67]. Instead of only learning concepts, students should be involved in activities that directly interact with the objects being studied at the concrete operational stage. Applying a concept helps students remember and understand it better. Meanwhile, the ability to analyze requires habituation beginning at a young age [31], [66].

Students are more engaged in science learning when using appropriate, interesting, and fun learning methods and media [13], [20], [68]. This is consistent with previous findings [11], [69], which found that the use of visual multimedia and hands-on activities improves students' attitudes toward learning science in elementary and tertiary institutions. Students in the experimental class achieve better levels of remembering, understanding, and applying than those in the control class through hands-on exercises and role-playing activities. This instruction method can assist students in developing concepts about learning material, increasing learning motivation, and enhancing joyful perception during the learning process [70]–[73].

There is an increase in science concepts mastery through rote learning and teacher-centered modification into learning that is more contextual and meaningful as well as student-centered. The teacher enthusiastically attempts to lead the class in the most interesting way, while the participants enthusiastically and actively participate in each activity. When teachers and students arrive at school, they notice a pleasant atmosphere [46], [70].

4. CONCLUSION

The students' multiple intelligence modalities can be optimized through differentiated multiple-intelligence-based instruction. The intelligence developed includes logical-mathematical intelligence, language, kinesthetic, interpersonal and intrapersonal. Students feel the fun learning atmosphere and unstressed learning, so that multiple intelligences can naturally be developed. This instruction also influences the science mastery concept especially on remembering, understanding, and applying, through hands-on exercises and role-playing activities. The differentiated instruction based on multiple intelligences should be further developed to examine the effectiveness of the model in thematic learning in classes with lower and/or higher achievement. In addition, it is necessary to develop an effective assessment, so that it supports students' multiple intelligences

ACKNOWLEDGEMENTS

The authors would like to thank to Ministry of Education, Culture, Research, and Technology, Republic of Indonesia No. 072/E5/PG.02.00.PT/2022 who has provided the financial support for this study.

REFERENCES

- [1] M. Bulunuz, "The role of playful science in developing positive attitudes toward teaching science in a science teacher preparation program," *Eurasian Journal of Educational Research*, no. 55, pp. 67–88, Apr. 2015.
- [2] J. Camacho-Morles, G. R. Slemp, R. Pekrun, K. Loderer, H. Hou, and L. G. Oades, "Activity achievement emotions and academic performance: a meta-analysis," *Educational Psychology Review*, vol. 33, no. 3, pp. 1051–1095, Sep. 2021, doi: 10.1007/s10648-020-09585-3.
- [3] S. Zaccoletti, G. Altoè, and L. Mason, "Enjoyment, anxiety and boredom, and their control-value antecedents as predictors of reading comprehension," *Learning and Individual Differences*, vol. 79, Apr. 2020, doi: 10.1016/j.lindif.2020.101869.
- [4] K. Y. Y. Tam *et al.*, "Boredom begets boredom: An experience sampling study on the impact of teacher boredom on student boredom and motivation," *British Journal of Educational Psychology*, vol. 90, no. S1, pp. 124–137, Jun. 2020, doi: 10.1111/bjep.12309.
- [5] K. Durairaj, S. J. Bin Assarnurkuty, N. K. Thoe, and W. N. A. bt Mohd Sabri, "Development of a framework for an asynchronous discussion forum through an e-learning platform," *Dinamika Jurnal Ilmiah Pendidikan Dasar*, vol. 14, no. 2, pp. 128–139, Oct. 2022, doi: 10.30595/dinamika.v14i2.15274.
- [6] D. W. Yacek and K. Gary, "The uses and abuses of boredom in the classroom," *British Educational Research Journal*, vol. 49, no. 1, pp. 126–141, Feb. 2023, doi: 10.1002/berj.3833.
- [7] A. K. M. and A. Deshpande, "Disruptive teaching methodology for STEM education," *Journal of Engineering Education Transformations*, vol. 34, pp. 752–756, Jan. 2021, doi: 10.16920/jeet/2021/v34i0/157178.
- [8] A. Shishigu, A. Hailu, and Z. Anibo, "Problem-based learning and conceptual understanding of college female students in physics," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 14, no. 1, Nov. 2017, doi: 10.12973/ejmste/78035.
- [9] A. Halim, E. Mahzum, M. Yacob, I. Irwandi, and L. Halim, "The impact of narrative feedback, e-learning modules and realistic video and the reduction of misconception," *Education Sciences*, vol. 11, no. 4, Mar. 2021, doi: 10.3390/educsci11040158.
- [10] S. Celik, "Can differentiated instruction create an inclusive classroom with diverse learners in an elementary school setting?" *Journal of Education and Practice*, vol. 10, no. 6, pp. 31–40, Feb. 2019, doi: 10.7176/JEP/10-6-05.
- [11] S. Anggoro, A. Widodo, A. Suhandi, and D. F. Treagust, "Using a discrepant event to facilitate preservice elementary teachers' conceptual change about force and motion," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 15, no. 8, Apr. 2019, doi: 10.29333/ejmste/105275.
- [12] S. W.-Y. Wan, "Differentiated instruction: Hong Kong prospective teachers' teaching efficacy and beliefs," *Teachers and Teaching*, vol. 22, no. 2, pp. 148–176, Feb. 2016, doi: 10.1080/13540602.2015.1055435.
- [13] M. S. Ashfaq, "The impact of activity base joyful learning on academic achievement of students at elementary," *Research and Analysis Journal*, vol. 3, no. 3, pp. 177–191, 2020.
- [14] I. Y. Kazu, "The effect of learning styles on education and the teaching process," *Journal of Social Sciences*, vol. 5, no. 2, pp. 85–94, Feb. 2009, doi: 10.3844/jssp.2009.85.94.
- [15] V. Aleksić and M. Ivanović, "A literature review of empirical research on the effects of digital games on learning styles and multiple intelligences (Pregled literature o empirijskim istraživanjima o utjecaju digitalnih igara na stilove učenja i višestruke inteligencije)," *Croatian Journal of Education - Hrvatski časopis za odgoj i obrazovanje*, vol. 19, no. 2, Jan. 2017, doi: 10.15516/cje.v19i2.2060.
- [16] S. Sunil and M. N. Doja, "RSPAEP: A recommender system for personalized educational platform based on multiple intelligences," *Mukt Shabd Journal*, vol. 9, no. 7, pp. 1736–1746, 2020.
- [17] B. Shearer, "Multiple intelligences in teaching and education: Lessons learned from neuroscience," *Journal of Intelligence*, vol. 6, no. 3, Aug. 2018, doi: 10.3390/jintelligence6030038.
- [18] F. Fatima and S. Ali, "Philosophical and biological foundation of brain based learning: A phenomenological approach," *International Journal of Innovation in Teaching and Learning (IJITL)*, vol. 6, no. 2, pp. 1–16, Jan. 2021, doi: 10.35993/ijitl.v6i2.831.

- [19] A. Sani, D. Rochintaniawati, and N. Winarno, "Enhancing students' motivation through brain-based learning," *Journal of Physics: Conference Series*, vol. 1157, Feb. 2019, doi: 10.1088/1742-6596/1157/2/022059.
- [20] S. Anggoro, W. Sopandi, and M. Sholehuddin, "Influence of Joyful learning on elementary school students' attitudes toward science," *Journal of Physics: Conference Series*, vol. 812, Feb. 2017, doi: 10.1088/1742-6596/812/1/012001.
- [21] J. Willis, *How your child learns best: brain-friendly strategies you can use to ignite your child's learning and increase school success*. Sourcebooks, 2008.
- [22] S. S. K. Mohd Yatim, S. Saleh, H. Zulnaidi, and S. A. M. Yatim, "Effects of integrating a brain-based teaching approach with GeoGebra on problem-solving abilities," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 11, no. 4, pp. 2078–2086, Dec. 2022, doi: 10.11591/ijere.v11i4.22873.
- [23] S. Şener and A. Çokçalışkan, "An investigation between multiple intelligences and learning styles," *Journal of Education and Training Studies*, vol. 6, no. 2, Jan. 2018, doi: 10.11114/jets.v6i2.2643.
- [24] P. Alavinia and A. Viyani, "Role of differentiated listening instruction via attending to learners' multiple intelligences in enhancing listening performance of Iranian learners," *International Journal of English Language & Translation Studies*, vol. 6, no. 3, pp. 12–21, 2018.
- [25] G. Colquitt, T. Pritchard, C. Johnson, and S. McCollum, "Differentiating instruction in physical education: Personalization of learning," *Journal of Physical Education, Recreation & Dance*, vol. 88, no. 7, pp. 44–50, Sep. 2017, doi: 10.1080/07303084.2017.1340205.
- [26] C. A. Tomlinson and C. A. Strickland, *Differentiation in practice: a resource guide for differentiating curriculum, grades 9-12*. Association for Supervision and Curriculum Development; Illustrated edition, 2005.
- [27] J. L. Maeng and R. L. Bell, "Differentiating science instruction: Secondary science teachers' practices," *International Journal of Science Education*, vol. 37, no. 13, pp. 2065–2090, Sep. 2015, doi: 10.1080/09500693.2015.1064553.
- [28] K.-T. Lindner and S. Schwab, "Differentiation and individualisation in inclusive education: a systematic review and narrative synthesis," *International Journal of Inclusive Education*, pp. 1–21, Sep. 2020, doi: 10.1080/13603116.2020.1813450.
- [29] I. S. I. Magableh and A. Abdullah, "On the effectiveness of differentiated instruction in the enhancement of Jordanian students' overall achievement," *International Journal of Instruction*, vol. 13, no. 2, pp. 533–548, Apr. 2020, doi: 10.29333/iji.2020.13237a.
- [30] A. Nichols Hess and K. Greer, "Designing for engagement: Using the ADDIE model to integrate high-impact practices into an online information literacy course," *CommInfoLit*, vol. 10, no. 2, pp. 264–282, 2016, doi: 10.15760/comminfoLit.2016.10.2.27.
- [31] L. Cohen, L. Manion, and K. Morrison, "Experiments, quasi-experiments, single-case research and meta-analysis," in *Research Methods in Education*, Routledge Taylor & Francis Group, 2007.
- [32] D. R. Krathwohl, "A revision of bloom's taxonomy: An overview," *Theory into Practice*, vol. 41, no. 4, pp. 212–218, Nov. 2002, doi: 10.1207/s15430421tip4104_2.
- [33] D. R. Krathwohl and L. W. Anderson, "Merlin C. Wittrock and the revision of bloom's taxonomy," *Educational Psychologist*, vol. 45, no. 1, pp. 64–65, Jan. 2010, doi: 10.1080/00461520903433562.
- [34] D. E. Meltzer, "The relationship between mathematics preparation and conceptual learning gains in physics: A possible 'hidden variable' in diagnostic pretest scores," *American Journal of Physics*, vol. 70, no. 12, pp. 1259–1268, Dec. 2002, doi: 10.1119/1.1514215.
- [35] A. Cichocki and A. P. Kuleshov, "Future trends for human-AI collaboration: A comprehensive taxonomy of AI/AGI using multiple intelligences and learning styles," *Computational Intelligence and Neuroscience*, vol. 2021, pp. 1–21, Feb. 2021, doi: 10.1155/2021/8893795.
- [36] G. Scarparolo and P. Subban, "A systematic review of pre-service teachers' self-efficacy beliefs for differentiated instruction," *Teachers and Teaching*, vol. 27, no. 8, pp. 753–766, Nov. 2021, doi: 10.1080/13540602.2021.2007371.
- [37] H. Ismajli and I. Imami-Morina, "Differentiated instruction: Understanding and applying interactive strategies to meet the needs of all the students," *International Journal of Instruction*, vol. 11, no. 3, pp. 207–218, Jul. 2018, doi: 10.12973/iji.2018.11315a.
- [38] L. M. Brevik, A. E. Gunnulfsen, and J. S. Renzulli, "Student teachers' practice and experience with differentiated instruction for students with higher learning potential," *Teaching and Teacher Education*, vol. 71, pp. 34–45, Apr. 2018, doi: 10.1016/j.tate.2017.12.003.
- [39] C. Cummings, D. Mason, K. Shelton, and K. Baur, "Active learning strategies for online and blended learning environments," in *Flipped Instruction*, IGI Global, 2047, pp. 88–114. doi: 10.4018/978-1-5225-1803-7.ch006.
- [40] A. Perveen, "Facilitating multiple intelligences through multimodal Learning analytics," *Turkish Online Journal of Distance Education*, vol. 19, no. 1, pp. 18–30, Jan. 2018, doi: 10.17718/tojde.382655.
- [41] N. Pereira, J. Tay, Y. Maeda, and M. Gentry, "Differentiation as measured by the classroom practices survey: a validity study updating the original instrument," *Learning Environments Research*, vol. 22, no. 3, pp. 443–460, Oct. 2019, doi: 10.1007/s10984-019-09284-z.
- [42] H. J. Cha and M. L. Ahn, "Design and development of a smart-tool prototype to promote differentiated instruction: a user-centered design approach," *Interactive Learning Environments*, vol. 28, no. 6, pp. 762–778, Aug. 2020, doi: 10.1080/10494820.2018.1552871.
- [43] E. M. Dijkstra, A. Walraven, T. Mooij, and P. A. Kirschner, "Factors affecting intervention fidelity of differentiated instruction in kindergarten," *Research Papers in Education*, vol. 32, no. 2, pp. 151–169, Mar. 2017, doi: 10.1080/02671522.2016.1158856.
- [44] R. Boelens, M. Voet, and B. De Wever, "The design of blended learning in response to student diversity in higher education: Instructors' views and use of differentiated instruction in blended learning," *Computers & Education*, vol. 120, pp. 197–212, May 2018, doi: 10.1016/j.compedu.2018.02.009.
- [45] D. Zeraï, S. Eskelä-Haapanen, H. Posti-Ahokas, and T. Vehkakoski, "The meanings of differentiated instruction in the narratives of Eritrean teachers," *Pedagogy, Culture & Society*, vol. 31, no. 3, pp. 419–437, May 2023, doi: 10.1080/14681366.2021.1914712.
- [46] F. Azizah, S. Anggoro, and A. Hayati, "Developing and validating of differentiated instruction based multiple intelligence," in *Proceedings of the 1st International Conference on Social Sciences, ICONESS 2021*, 2021. doi: 10.4108/eai.19-7-2021.2312782.
- [47] A. Hayati, S. Anggoro, and F. Azizah, "Development and validation design of differentiated instruction based learning style of fifth grade science learning," in *Proceedings of the 1st International Conference on Social Sciences, ICONESS 2021*, 2021. doi: 10.4108/eai.19-7-2021.2312781.
- [48] K. Shabani, "Applications of Vygotsky's sociocultural approach for teachers' professional development," *Cogent Education*, vol. 3, no. 1, Dec. 2016, doi: 10.1080/2331186X.2016.1252177.
- [49] X. Chen and D. Meurers, "Challenging learners in their individual zone of proximal development using pedagogic developmental benchmarks of syntactic complexity," in *Proceedings of the joint workshop on NLP for Computer Assisted Language Learning and NLP for Language Acquisition*, 2017, pp. 8–17.
- [50] L.-E. Díaz-Posada, S.-P. Varela-Londoño, and L.-P. Rodríguez-Burgos, "Multiple intelligences and curriculum implementation: progress, trends and opportunities," *Revista de Psicodidáctica*, vol. 22, no. 1, pp. 69–83, 2017.




- [51] V. Batdi, "The effect of multiple intelligences on academic achievement: A meta-analytic and thematic study," *Educational Sciences: Theory & Practice*, vol. 17, no. 6, 2017, doi: 10.12738/estp.2017.6.0104.
- [52] K. Hajhashemi, N. Caltabiano, and N. Anderson, "Multiple intelligences, motivations and learning experience regarding video-assisted subjects in a Rural University," *International Journal of Instruction*, vol. 11, no. 1, pp. 167–182, Jan. 2018, doi: 10.12973/iji.2018.11112a.
- [53] R. Yavich and I. Rotnitsky, "Multiple intelligences and success in school studies," *International Journal of Higher Education*, vol. 9, no. 6, Sep. 2020, doi: 10.5430/ijhe.v9n6p107.
- [54] V. Strogilos, L. Lim, and N. Binte Mohamed Buhari, "Differentiated instruction for students with SEN in mainstream classrooms: contextual features and types of curriculum modifications," *Asia Pacific Journal of Education*, vol. 43, no. 3, pp. 850–866, Jul. 2023, doi: 10.1080/02188791.2021.1984873.
- [55] D. Erdem and I. Keklik, "Multiple intelligences profiles in prospective teachers," *Education Reform Journal*, vol. 5, no. 1, pp. 27–44, Jun. 2020, doi: 10.22596/erj2020.05.01.27.44.
- [56] U. Faizah, A. Permanasari, and N. Y. Rustaman, "How did lecturers and students adapt to online learning during the COVID-19 pandemic?" in *Proceedings of the 5th Asian Education Symposium 2020 (AES 2020)*, 2021, doi: 10.2991/assehr.k.210715.029.
- [57] B. P. Godor, "The many faces of teacher differentiation: using Q methodology to explore teachers preferences for differentiated instruction," *The Teacher Educator*, vol. 56, no. 1, pp. 43–60, Jan. 2021, doi: 10.1080/08878730.2020.1785068.
- [58] M. J. Gohar and N. Sadeghi, "English and education Gardner's multiple intelligence theory and foreign language achievement," *International Journal of English and Education*, vol. 4, no. 1, pp. 206–216, 2015.
- [59] W. Smets and K. Struyven, "A teachers' professional development programme to implement differentiated instruction in secondary education: How far do teachers reach?" *Cogent Education*, vol. 7, no. 1, Jan. 2020, doi: 10.1080/2331186X.2020.1742273.
- [60] P. Alavinia and S. Farhady, "Using differentiated instruction to teach vocabulary in mixed ability classes with a focus on multiple intelligences and learning styles," *International Journal of Applied Science and Technology*, vol. 2, no. 4, pp. 72–82, 2012.
- [61] M. Lemmer, "Applying the science of learning to the learning of science: newton's second law of motion," *Africa Education Review*, vol. 15, no. 1, pp. 20–37, Jan. 2018, doi: 10.1080/18146627.2016.1224591.
- [62] D. R. Richards, "The integration of the multiple intelligence theory into the early childhood curriculum," *American Journal of Educational Research*, vol. 4, no. 15, pp. 1096–1099, 2016.
- [63] J. M. Faber, C. A. W. Glas, and A. J. Visscher, "Differentiated instruction in a data-based decision-making context," *School Effectiveness and School Improvement*, vol. 29, no. 1, pp. 43–63, Jan. 2018, doi: 10.1080/09243453.2017.1366342.
- [64] S. Paik, G. Song, S. Kim, and M. Ha, "Developing a four-level learning progression and assessment for the concept of buoyancy," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 13, no. 8, Aug. 2017, doi: 10.12973/eurasia.2017.00976a.
- [65] R. Hirvonen, D. W. Putwain, S. Määttä, T. Ahonen, and N. Kiuru, "The role of academic buoyancy and emotions in students' learning-related expectations and behaviours in primary school," *British Journal of Educational Psychology*, vol. 90, no. 4, pp. 948–963, Dec. 2020, doi: 10.1111/bjep.12336.
- [66] A. Arun and G. Singaravelu, "Brain-based learning: a tool for meaningful learning in the classroom," *International Journal of Research*, vol. 7, no. 9, pp. 766–771, 2018.
- [67] M. Evagorou, C. Nicolaou, and C. Lymbouridou, "Modelling and argumentation with elementary school students," *Canadian Journal of Science, Mathematics and Technology Education*, vol. 20, no. 1, pp. 58–73, Mar. 2020, doi: 10.1007/s42330-020-00076-9.
- [68] M. Swan, G. Wake, and M. Joubert, "Developing conceptual understanding through cognitive conflict and discussion in mathematics and science education," *Centre for Research in Mathematics Education University of Nottingham: FaSMEd Position Paper*, pp. 1–5, 2006.
- [69] S. Sundaram and R. Ramesh, "Effectiveness of joyful game-based blended learning method in learning chemistry during COVID-19," *International Journal of Evaluation and Research in Education (IJERE)*, vol. 11, no. 4, pp. 2140–2146, Dec. 2022, doi: 10.11591/ijere.v11i4.22427.
- [70] S. Tuningsih, S. Anggoro, and N. Hermita, "The reconstructing of 4th grade primary students' conception on the concept of geometry using puzzle based learning," *Journal of Physics: Conference Series*, vol. 1655, no. 1, Oct. 2020, doi: 10.1088/1742-6596/1655/1/012080.
- [71] A. Malik *et al.*, "Enhancing communication skills of pre-service physics teacher through HOT lab related to electric circuit," *Journal of Physics: Conference Series*, vol. 953, Jan. 2018, doi: 10.1088/1742-6596/953/1/012017.
- [72] C. A. Talib, H. Aliyu, F. Aliyu, A. M. A. Malik, S. Anggoro, and M. Ali, "Integration of robotics into STEM education for facilitating environmental sustainability," *Solid State Technology*, vol. 63, no. 1, pp. 767–783, 2020.
- [73] K. Bilican, V. Akerson, and V. Nargund, "Learning by teaching: a case study of co-teaching to enhance nature of science pedagogy, successes, and challenges," *International Journal of Science and Mathematics Education*, vol. 19, no. 5, pp. 957–976, Jun. 2021, doi: 10.1007/s10763-020-10094-6.

APPENDIX




Activity/Description	Preferred activity Multiple Intelligence and Learning Style	Observed indicators Activity	Allocation
Introduction activities <ul style="list-style-type: none"> • Checking students' attendance. • Starting learning activities by getting students physically and psychologically ready for class. • Inviting students to mention the type of jobs and equipment/materials used through clap game (Learning by playing). • Delivering today's learning objectives. 	Body Kinesthetic Physical experience and movement, touch and feel	An environment that is relaxed, pleasant, not stressful, safe, interesting, does not make students hesitate to do something even if it is wrong to achieve high success	10 minutes
Main activities <ul style="list-style-type: none"> • The Teacher asks students to discuss the greatness of fishermen and farmers. • The teacher provides question stimulants (Learn by problem solving). Examples of Questions: <ul style="list-style-type: none"> – What do fishermen and farmers usually do? – What happens if there are no fishermen and farmers? – What will happen to fishermen and farmers if the sea and land are polluted? – Why will deforestation affect the lives of farmers and fishermen? • The teacher asks students to make a group of four to share their opinions. While the other groups are asked to give their opinion and ask questions • The teacher asks students to read the story about dr. Oen carefully • Teachers provides stimulant questions based on pictures in students' books. Sample questions: <ul style="list-style-type: none"> – What did the person do? – How is the situation described in the photo? – What's interesting about the picture? – What can you see from the picture? – What do doctors usually do? – What happens if doctors are not available? • Each group consisting of four people will share their opinions. • The teacher reminds about the technology used by the doctor. The student will mention an example and the stethoscope • When students mention the stethoscope, the teacher will link the activities to be carried out today, namely making experiment by a simple stethoscope creation (Learn by Doing) • The teacher can provide stimulant questions such as: <ul style="list-style-type: none"> – What do you know about stethoscopes? – What are the steps for making a simple stethoscope? – What needs attention • The teacher divides students into several groups. One group consists of 4 students. They can bring tools and materials from home or prepared by the teacher. • After students make a simple stethoscope, they will fill in the experiment report in the student book and make conclusions about the relationship between the nature of sound 	Linguistic, Interpersonal, Words and language and Human contact, communications, cooperation, teamwork Body Kinesthetic, Interpersonal, Physical experience and Movement, touch and feel, and Human contact, communications, cooperation, teamwork	There is a challenging learning situation for students to think far ahead and explore the material being studied There is a challenging learning situation (challenging) for students to think far ahead and explore the material being studied Guaranteed availability of relevant subject matter and methods; Involvement of all the senses and left and right brain activity There are positive emotional learning situations when students study together, and when there is humor, encouragement, time off, and enthusiastic support.	80 minutes
Closing activities Students write down their learning experiences about the material they have learned. The teacher conveys a moral message about attitudes towards work wisely. Task: Pay attention to the people around your home environment (surrounding). Write down the jobs and types of the products they produced (goods/services) Enrichment Students can find information about modern technology about medicine (library books, encyclopedias, and human resources /teachers in the school environment).	Intrapersonal Self-reflection, self-discovery	Involvement of all senses and left and right brain activity	15 minutes

BIOGRAPHIES OF AUTHORS






Subuh Anggoro    is an Associate Professor and Teacher Educator at, Primary School Teacher Education Department, Universitas Muhammadiyah Purwokerto (UMP). He is passionate about raising the quality of teaching and learning of students and their development both in the schools and in the higher education settings. Dr Anggoro's research interests include the teacher and teacher education, science education, higher education, 21st Century teaching and learning, school-based assessment, and classroom research, youth practices and their education His email addresses are subuhanggoro@ump.ac.id; subuhanggoro@gmail.com.






Azmi Fitriati    is an Assistant Professor in Accounting Information Systems at Universitas Muhammadiyah Purwokerto in Purwokerto, Central Java, Indonesia. She received her doctorate in the field of Accounting Information Systems, from Padjadjaran University, Bandung, Indonesia. Her areas of interest in research include information systems, accounting information systems and organizational and human factors that influence these systems. Her email address is azmi.fitriati@gmail.com.






Ng Khar Thoe    received the Ph.D in Education from Open University Malaysia (OUM); M.Ed. from Brunel University of West London; B.Sc.Ed.(Hons.) from USM. She is an advocate for science integrating transdisciplinary approaches, founder of a few project-based programmes including LeSMaT (Borderless) and Education 4.0 project funded by SEAMEO for Inter-Centre Collaboration (ICC). She has wide experience as school teacher/specialist/tutor/trainer/academic facilitator/thesis supervisor (Wawasan Open University) and proposal examiner/adjunct senior lecturer (Asia e University)/adjunct Asst. Prof. (UCSI University, Kuala Lumpur). She is the life member and Technical Advisor of Society for Research Development (SRD). She can be contacted at email: postgradreview@gmail.com, lesmatproject@gmail.com.



Corrienna Abdul Talib    has been a Senior Lecturer in Chemistry Education Department of Educational Science, Mathematics and Creative Multimedia, School of Education, Universiti Teknologi Malaysia (UTM), Johor since 2015. She received her PhD degree in the field of Chemistry Education from Universiti Sains Malaysia. She is the President of Johor Science and Mathematics Education Association and life member of Society for Research Development. Currently, she has several copyrights such as the Scratchtopia Challenge and award-winning research projects related to technology, which have led her to be invited as a keynote speaker, guest speaker, visiting professor, to name a few. She can be contacted at email: corrienna@utm.my, drcorrienna@gmail.com.



Lia Mareza    is a Senior Assistant Professor at Department of Education, Universitas Muhammadiyah Purwokerto (UMP), KH Ahmad Dahlan Street, Banyumas 53182. Her research focuses on psychology of art for primary school, literacy visual and character education. She can be contacted at email: liamareza4@gmail.com, azlina@utm.my.