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

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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 effectiveness 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.

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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].

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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, teachers 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 effectiveness of instruction in promoting 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 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
Differentiated instruction based on multiple intelligences as promising joyful … (Subuh Anggoro)

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.

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.
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.
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

<table>
<thead>
<tr>
<th>Concept mastery level</th>
<th>Group</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Mean difference</th>
<th>Std. error difference</th>
<th>T</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remembering</td>
<td>1. Experiment</td>
<td>0.403</td>
<td>0.222</td>
<td>0.220</td>
<td>0.044</td>
<td>5.053</td>
<td>75</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>2. Control</td>
<td>0.183</td>
<td>0.153</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding</td>
<td>1. Experiment</td>
<td>0.232</td>
<td>0.137</td>
<td>0.079</td>
<td>0.029</td>
<td>2.755</td>
<td>75</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>2. Control</td>
<td>0.155</td>
<td>0.109</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applying</td>
<td>1. Experiment</td>
<td>0.552</td>
<td>0.326</td>
<td>0.323</td>
<td>0.060</td>
<td>5.392</td>
<td>75</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>2. Control</td>
<td>0.229</td>
<td>0.184</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analyzing</td>
<td>1. Experiment</td>
<td>0.200</td>
<td>0.160</td>
<td>-0.087</td>
<td>0.040</td>
<td>-2.193</td>
<td>75</td>
<td>0.032</td>
</tr>
<tr>
<td></td>
<td>2. Control</td>
<td>0.287</td>
<td>0.176</td>
<td></td>
<td></td>
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</tbody>
</table>

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].

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

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<table>
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<th>APPENDIX</th>
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<tr>
<td><strong>Activity/Description</strong></td>
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<tr>
<td><strong>Introduction activities</strong></td>
</tr>
<tr>
<td>- Checking students’ attendance.</td>
</tr>
<tr>
<td>- Starting learning activities by getting students physically and psychologically ready for class.</td>
</tr>
<tr>
<td>- Inviting students to mention the type of jobs and equipment/materials used through clap game (Learning by playing).</td>
</tr>
<tr>
<td>- Delivering today’s learning objectives.</td>
</tr>
<tr>
<td><strong>Main activities</strong></td>
</tr>
<tr>
<td>- The teacher asks students to discuss the greatness of fishermen and farmers.</td>
</tr>
<tr>
<td>- The teacher provides question stimulants (Learn by problem solving): Examples of Questions:</td>
</tr>
<tr>
<td>- What do fishermen and farmers usually do?</td>
</tr>
<tr>
<td>- What happens if there are no fishermen and farmers?</td>
</tr>
<tr>
<td>- What will happen to fishermen and farmers if the sea and land are polluted?</td>
</tr>
<tr>
<td>- Why will deforestation affect the lives of farmers and fishermen?</td>
</tr>
<tr>
<td>- The teacher asks students to make a group of four to share their opinions. When the other groups are asked to give their opinion and ask questions</td>
</tr>
<tr>
<td>- The teacher asks students to read the story about dr. Oen carefully</td>
</tr>
<tr>
<td>- Teachers provides stimulant questions based on pictures in students' books. Sample questions:</td>
</tr>
<tr>
<td>- What did the person do?</td>
</tr>
<tr>
<td>- How is the situation described in the photo?</td>
</tr>
<tr>
<td>- What's interesting about the picture?</td>
</tr>
<tr>
<td>- What can you see from the picture?</td>
</tr>
<tr>
<td>- What do doctors usually do?</td>
</tr>
<tr>
<td>- What happens if doctors are not available?</td>
</tr>
<tr>
<td>- Each group consisting of four people will share their opinions.</td>
</tr>
<tr>
<td>- The teacher reminds about the technology used by the doctor. The student will mention an example and the stethoscope</td>
</tr>
<tr>
<td>- 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)</td>
</tr>
<tr>
<td>- The teacher can provide stimulant questions such as:</td>
</tr>
<tr>
<td>- What do you know about stethoscopes?</td>
</tr>
<tr>
<td>- What are the steps for making a simple stethoscope?</td>
</tr>
<tr>
<td>- What needs attention</td>
</tr>
<tr>
<td>- 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.</td>
</tr>
<tr>
<td>- 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</td>
</tr>
<tr>
<td><strong>Closing activities</strong></td>
</tr>
<tr>
<td>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)</td>
</tr>
<tr>
<td>Enrichment</td>
</tr>
</tbody>
</table>
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