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Differentiated Learning Technology on Science Education to Students Learning Outcomes

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Abstract: Enhancing student learning by matching student characteristics with learning and assessment, using not just one strategy but a combination of strategies. This research is an experimental research on the use of Differentiated Learning model. Differentiated learning model is a learning model that accommodates the differences that exist in students, be it abilities, learning styles, interests, talents etc.. This study aims to see the effect of using a differentiated learning model on the learning outcomes of class X students in the sociology subject matter of social research at SMAN 2 West Sumatra. This research is a Quasi experimental research that uses The Nonequivalent Control Group design by using experimental class and control class. The data processed in this study are data from the pretest and post-test results from the experimental class and control class in accordance with The Nonequivalent Control Group design.After conducting several data tests in this study, it is proven that differentiated learning models can improve learning outcomes, and this can prove the research hypothesis that there is a significant influence between differentiated learning models and learning outcomes.

Keywords: Differentiated Learning; Education; Science; Technology

Introduction

Reality that author found in the field where the author teaches at SMAN 2 West Sumatra, a school located on Jalan Lintas Sumatera, Jlan Koto Gaek, Guguk, Gunung Talang District, Kab.Solok is one of the boarding schools (Boarding School), a school whose students come from diverse regions, ethnicities and even different religions throughout the regions in West Sumatra (Syahdila, 2021). In practice, the learning process activities carried out in the classroom still rely on the teacher as the only source of learning (Sumardi et al., 2020), still dominated by the transfer of knowledge from a teacher to students, and also dominated by the teacher as the centre in the learning process, dominated by conventional learning models, which causes the level of activeness of children is very lacking (Hernandez-de-Menendez et al., 2020). Where with the application of the learning model affects the learning outcomes of a child (Bao et al., 2020), the learning outcomes of a child are not low, because each has a different capacity and learning style from one another (Alam, 2022; Gusnarib & Rosnawati, 2021).

Carol A. Tomlinson, an educationist since 1995 has studied about differentiated learning in her book entitled How to Differentiate Instruction in Mixed Ability Classroom (Adams, 2020; Davis, 2020). Where in differentiated learning, teachers must teach or provide material to students by paying attention to the level of readiness, interest, learning style of students (Demir, 2021; Ginja & Chen, 2020) and also in the learning process teachers must be able to modify the learning content (Renzulli, 2023; Roberts & Inman, 2023), learning process, product and results of the learning and also pay attention to the learning environment of students (Tomlinson & Imbeau, 2023).

In accordance with the independent curriculum, learning should be directed according to the abilities of students and according to the differences that exist in students (Pozas et al., 2020). This is clearly seen with students who score low while in terms of their abilities are high, and also because many students are less

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enthusiastic in participating in learning activities. This is thought to be caused by the learning process carried out by the teacher has not been in accordance with the learning style of these learners.

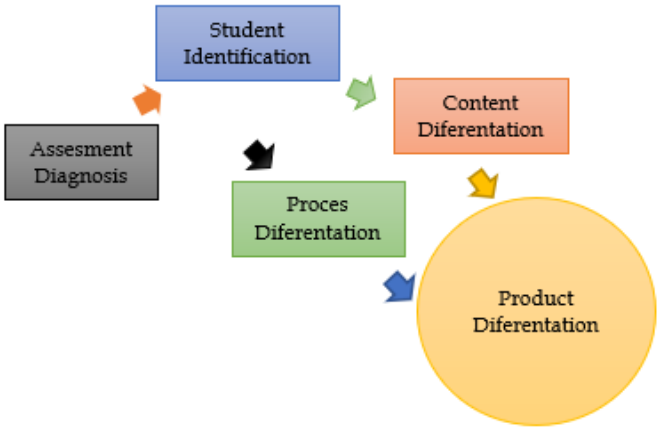

Figure 1. Differentiated project-based learning (Source: Prayoga & Muslihati, 2021)

The assessment carried out by the teacher has not been in accordance with the interests of the students' talents. A teacher as an educator is not enough to only have knowledge about the subjects he/she teaches. But also must have skills in increasing the activeness of students in learning. Teachers must also be able to provide experiences in learning to their students. Therefore, improving teacher performance in the learning process in the classroom will greatly affect student learning outcomes later.

Method

The type of research used in this study is descriptive research with a qualitative approach and quantitative approach (King, 1991). Researchers may choose to observe lots of cases superficially, or a few cases more intensively (Creswell & Creswell, 2018). The data taken, identified in the following order: data collection; data sorting; data analysis; and conclusion making. As for data analysis, there is a predetermined sequence in accordance with the empirical steps taken, namely as follows: Examination of data; suspected data findings; Data confirmation; Diagnosis; and Action.

This research is included in quasi experimental research (Quasi experiment) Experimental research is research that is intended to determine whether or not there is an effect of something that is imposed on the subject of investigation. The experimental class group, namely class X.E 2, was given differentiated learning treatment and the control class, namely class X.E 3, was given conventional learning. Then a posttest and pretest were conducted to see the comparison of results after the experiment.

Result and Discussion

Differentiated Learning Technology on Science Education

In today's society everything is happening on the Internet, in particular on social networks. Social networks play central role in everyday life of average people (Milano, 2018). Recent years have seen tremendous advances in theory development, research, and practice relevant to the field of the self-regulation of learning and performance in educational settings (Greene, 2017). So Differentiated Instruction or Differentiated Teaching was first introduced by Carol Ann Tomlinson. According to Tomlinson, Differentiated Instruction (DI) is not a strategy, a programme or a "thing". DI is a way of thinking. A philosophy of how to respond to student differences by adapting instruction to meet student needs. In another book, Tomlinson suggests that DI is learning that is tailored to the needs of students with the aim of maximising the potential of each student (Defitriani, 2019).

Similarly, ASCD or Association of Supervision and Curriculum Development defines DI as a form of learning that seeks to maximise students' learning growth by seeking information on the level of students' learning abilities, then helping them to develop and advance (Parwati et al., 2023; Tanaka et al., 2023). More specifically, Access Centre defines DI as a process of enhancing student learning by matching student characteristics with learning and assessment, using not just one strategy but a combination of strategies (Defitriani, 2019). Why the distinction? There are three perspectives that can differences in cognitive development and ability, multiple intelligences, and learning styles and preferences. As is well known, that cognitive development children go through several stages, starting with sensory and gross motor skills, concrete thinking, and abstract operations. Although the stages passed by each child are the same, the development process is passed at different speeds (Defitriani, 2019; Sani et al., 2023).

Teachers are responsible for planning learning according to the stages of students' cognitive development. In addition, teachers must also know the student's zone of proximal development, which is the difference between the student's actual development and what he can do independently and the student's potential level of development and what he can achieve with help from adults or more advanced peers (Defitriani, 2019; Wibowo, 2020; Wormeli, 2023). Differentiation requires the teacher to vary their approaches in order to accommodate various learning styles, ability levels and interests (Lindner & Schwab, 2020). The Curriculum advocates the use of a broad range of active learning methodologies such as use of the environment, talk and discussion, collaborative work and use of ICT. To see an overview of the various

methodologies that can be employed across the curriculum as well as those that pertain to certain subjects. Remember, the greater the variety in the methodologies adopted by the teacher, the more pathways and entry points into learning s/he provides for the children(Vantassel-Baska, 2013).

There are a number of strategies which can be employed to support differentiated teaching and learning. The various tools outlined below contribute in different ways to effective differentiation. We recommend that you begin by trying one of these rather than attempting to implement them all at once. You may find that some are more useful to you than others depending on your needs as a teacher and the profile of your class(Vantassel-Baska, 2013). Artificial Intelligence (AI) techniques are being increasingly deployed in finance, in areas such as asset management, algorithmic trading, credit underwriting or blockchain-based finance, enabled by the abundance of available data and by affordable computing capacity. Machine learning (ML) models use big data to learn and improve predictability and performance automatically through experience and data, without being programmed to do so by humans (OECD, 2021).

The diagram in Figure 2 shows the use of ICT in the context of Bloom's Taxonomy. Various applications and programmes appear at different levels. However it is also important to note that any ICT tool can span all levels according to the level of sophistication with which it is employed. For instance, a student with the basic word processing skills of typing and formatting font will operate at a lower level of the hierarchy compared to one who has the ability to present texts with appropriate spacing, bullets and tables (Vantassel-Baska, 2013).

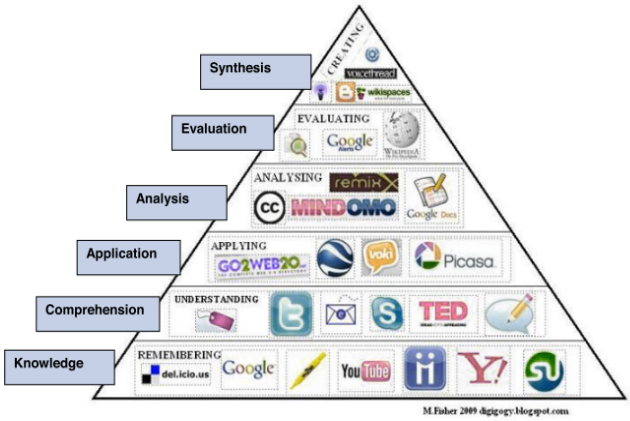

Figure 2. Model of Digital Taxonomy Blooms (Source: digigogy.blogspot.com)

ICT in and of itself is not a differentiation strategy. It is however a flexible tool that can facilitate the teacher to design a differentiated learning environment. Differentiating using technology requires that teachers think about hardware, software and web resources that support the teaching and learning while meeting the learning needs and styles of individual students. Moreover teachers need to consider how best to use the various applications towards tailoring the learning experiences for students (Vantassel-Baska, 2013).

ICT as a methodology has inherent characteristics that make it suitable for differentiation. It facilitates self-paced learning and choice for the learner. Through ICT students can explore, investigate and present their work with support when needed at their own pace and avail of multisensory methods when learning (Rose & Nicholl, 2023). Students can proceed as quickly or as slowly as he or she wishes (Vantassel-Baska, 2013). The computer will 'wait' for the student to respond without prompting them before they have had time to fully process the information and construct their response. Many programmes offer a menu of tasks which increase in complexity allowing the student to independently control the rate at which they move their learning forward. ICT presents information in many ways; visually, aurally, diagrammatically, text style and so on (Kertati et al., 2023). This means that there are multiple ways for students to acquire content, process ideas and develop products(Vantassel-Baska, 2013).

Validity and Reliability test results

The questions were tested on students who had studied social research material, namely class XI IPS SMAN 2 West Sumatra. The results of the validity test with the Product Moment formula Based on the results of the validity test of the 20 questions that were tested, all questions were valid with the interpretation of validity: 55% high, 45% sufficient. While the Reliability test results Based on the reliability test that has been carried out on the instrument used, the reliability value is obtained 0.91 with very high reliability criteria. Pretest score data is processed to see the initial ability of the control class and experimental class before being given the learning strategy treatment. After being given the treatment of each class, each class, was given a posttest to determine the extent to which the learning strategy provided could affect the learning outcomes of the two research samples.

The conclusion from the Wilcoxon Test results, based on SPSS output, shows that Asymp.Sig (2-Tailed) is 0.000. Because the value of 0.000 is smaller than 0.05, Ho is rejected and Ha is accepted, which means that there is an average difference between the PreTest and PostTest learning outcomes so that it can be said that there is a difference in the learning outcomes of the experimental and control classes. After obtaining the results of the homogeneity test which states that there is a difference in the means of two paired samples, then for the next test, hypothesis testing is carried out using the non-parametric test, namely the Mann Whitney U Test.

Furthermore, the results of the Experiment class posttest and the control class Posttest results obtained Asmp.Sig (2-tailed) are less than 0.05, namely 0.00 < 0.05. So based on this, the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted. So the hypothesis proposed in this study is accepted. Other research on the effect of differentiated learning models on student learning outcomes was also conducted by Abadi, Putri Rahma (2022) The effect of differentiated learning on student learning outcomes in Class 10 high school stoichiometry material. on student learning outcomes compared to conventional learning. based on the results of the t-test statistical analysis test. The average learning outcome of the experimental class was 85 40 greater than the average learning outcome of the control class of 77 04. (2) Students in the experimental class and control class showed different learning levels. Based on the decision-making criteria, the t-test result is 0 00, which means that the H0 hypothesis is rejected and the H1 hypothesis is accepted. Conclusion When compared to conventional learning (lecture) differentiated learning has an impact on student learning outcomes.

Conclusion

Recent years have seen tremendous advances in theory development, research, and practice relevant to the field of the self-regulation of learning and performance in educational settings. As used in this volume, self-regulation refers to the ways that learners systematically activate and sustain their cognitions, motivations, behaviors, and affects, toward the attainment of their goals. The distinction between self-regulation of learning and self- regulation of performance is that in the former the goals involve learning. A philosophy of how to respond to student differences by adapting instruction to meet student needs. In another book, Tomlinson suggests that DI is learning that is tailored to the needs of students with the aim of maximising the potential of each student. Based on the research and discussion that has been stated in the previous chapter, it can be seen that learning outcomes using differentiated learning models are higher than conventional learning models. This is reinforced from the results of the calculation of the hypothesis, namely the Mann Whitney U Test with a significance level of 0.05, obtained the results of the Pretest data calculation with the Mann Whitney U Test, the results show a significance value of 0.028 <0.05 with a Mean Rank of 33.23 for the experimental class while the Mean Rank is 27.77. So from these results it shows that there is not too much significant difference in sociology learning outcomes between the control class and the experimental class or it can be said to be relatively balanced, then the calculation of post-test data with the Mann Whitney U test shows a significance value of 0.000 <0.05 with a Mean Rank of the control class of 15.46 and for the mean rank of the Experimental class 41.54. So this shows that there is a significant difference in sociology learning outcomes between the control class and the experimental class. So the researcher gives advice Learning by using differentiated learning models can have a positive influence in improving student learning outcomes, especially sociology subject teachers who are fibre with material that can make students fall asleep in class if a learning model that suits their uniqueness is not applied.

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Conflicts of Interest
In this research, there is no tug of interest and or hidden interests among the researchers. In addition, this research is also not an order from any funder because it is an independent research, or in other words, the research team itself plays a role in preparing proposals, selecting topics, conceptualizing problems, collecting data, analyzing problems, drawing conclusions until the publication stage in this journal.

References

Adams, A. A. (2020). *Teacher and Student Perceptions of Differentiated Instruction and Its Effect on Student Achievement*. Trevecca Nazarene University.

Alam, A. (2022). A digital game based learning approach for effective curriculum transaction for teaching-learning of artificial intelligence and machine learning. *International Conference on Sustainable Computing and Data Communication Systems (ICSCDS)*, 69–74. https://doi.org/10.1109/ICSCDS53736.2022.9760932

Bao, X., Qu, H., Zhang, R., & Hogan, T. P. (2020). Modeling reading ability gain in kindergarten children during COVID-19 school closures.

International Journal of Environmental Research and Public Health, *17*(17), 6371. https://doi.org/10.3390/ijerph17176371

Creswell, J. W., & Creswell, J. D. (2018). *Research Design Qualitative, Quantitative, and Mixed Method Approaches by John W* (Creswell (ed.); fifth). SAGE Publications, Inc. z-lib.org.

Davis, C. (2020). *Elementary Reading Teachers' Perceptions about Differentiated Instruction* [Walden University]. Retrieved from https://shorturl.asia/UXZLN

Defitriani, E. (2019). Differentiated Instruction: Apa, Mengapa dan Bagaimana Penerapannya. *PHI: Jurnal Pendidikan Matematika*, *2*(2), 111–120. https://doi.org/10.33087/phi.v2i2.38

Demir, S. (2021). Effects of learning style based differentiated activities on gifted students' creativity. *Journal for the Education of Gifted Young Scientists*, *9*(1), 47–56. https://doi.org/10.17478/jegys.754104

Ginja, T. G., & Chen, X. (2020). Teacher Educators' Perspectives and Experiences towards Differentiated Instruction. *International Journal of Instruction*, *13*(4), 781–798. Retrieved from https://eric.ed.gov/?id=EJ1270682

Greene, J. A. (2017). *Handbook of self-regulation of learning and performance*. Routledge.

Gusnarib, G., & Rosnawati, R. (2021). *Teori-teori belajar dan pembelajaran*. Adab. Retrieved from https://repository.uindatokarama.ac.id/id/eprint/1405/

Hernandez-de-Menendez, M., Escobar Diaz, C. A., & Morales-Menendez, R. (2020). Educational experiences with Generation Z. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, *14*, 847–859. https://doi.org/10.1007/s12008-020-00674-9

Kertati, I., Zamista, A. A., Rahman, A. A., Yendri, O., Pratama, A., Rusmayadi, G., Nurhayati, K., Zebua, R. S. Y., Artawan, P., Arwizet, K. (2023). *Model & Metode Pembelajaran Inovatif Era Digital*. PT. Sonpedia Publishing Indonesia.

King, G. R. D. (1991). Excavations by the British team at Julfr, Ras-al-Khaimah, United Arab Emirates: Interim report on the second season (1990). *Proceedings of the Seminar for Arabian Studies*, 123–134. Retrieved from https://www.jstor.org/stable/41223108

Lindner, K.-T., & Schwab, S. (2020). Differentiation and individualisation in inclusive education: a systematic review and narrative synthesis. *International Journal of Inclusive Education*, 1–21. https://doi.org/10.1080/13603116.2020.1813450

Milano, P. D. I. (2018). *Machine Learning Techniques for Social Media Analysis*. Retrieved from https://shorturl.asia/z0sn2

OECD. (2021). *Artificial Intelligence, Machine Learning and Big Data in Finance: Opportunities, Challenges, and Implications for Policy Makers*. OECD Business and Finance Outlook 2020 : Sustainable and Resilient Finance. Retrieved from https://shorturl.asia/z6kEV

Parwati, N. N., Suryawan, I. P. P., & Apsari, R. A. (2023). *Belajar dan pembelajaran*. PT. RajaGrafindo Persada-Rajawali Pers.

Pozas, M., Letzel, V., & Schneider, C. (2020). Teachers and differentiated instruction: exploring differentiation practices to address student diversity. *Journal of Research in Special Educational Needs*, *20*(3), 217–230. https://doi.org/10.1111/1471-3802.12481

Prayoga, A., & Muslihati, M. (2021). Strategi Sosialisasi Wakaf Di Era Digital Melalui Platform Online Dengan Konsep Crowdfunding Pada Lembaga Aksi Cepat Tanggap (ACT) Sulawesi Selata. *AT TAWAZUN: Jurnal Ekonomi Islam*, *1*(3), 1–16. Retrieved from https://shorturl.asia/m7Ykg

Renzulli, J. (2023). *The multiple menu model: A practical guide for developing differentiated curriculum*. Taylor & Francis.

Roberts, J. L., & Inman, T. F. (2023). *Strategies for differentiating instruction: Best practices for the classroom*. Taylor & Francis.

Rose, C., & Nicholl, M. J. (2023). *Revolusi belajar accelerated learning for the 21st century*. Nuansa Cendekia.

Sani, S., Nurcahyono, N. A., & Lukman, H. S. (2023). Systematic Literature Review: Supporting Factors for Implementation of The Minimum Competency Assessment (AKM) at School. *Journal of Authentic Research on Mathematics Education (JARME)*, *5*(2), 234–242. https://doi.org/10.37058/jarme.v5i2.5818

Sumardi, L., Rohman, A., & Wahyudiati, D. (2020). Does the Teaching and Learning Process in Primary Schools Correspond to the Characteristics of the 21st Century Learning?. *International Journal of Instruction*, *13*(3), 357–370. Retrieved from https://eric.ed.gov/?id=EJ1259424

Syahdila, A. Y. (2021). Indonesian cultural diversity learning for 4th grader students. *ARDU: Journal of Arts and Education*, *1*(2), 45–51. https://doi.org/10.56724/ardu.v1i2.44

Tanaka, A., Gani, R. A., Kom, S., Andani, F., Martini, E., Udin, D. R. T., Firmansyah, S. P., Surahmi, N., RMIK, A. M., & Wewe, M. (2023). *Perencanaan pembelajaran*. Selat Media.

Tomlinson, C. A., & Imbeau, M. B. (2023). *Leading and managing a differentiated classroom*. Ascd.

Vantassel-Baska, J. (2013). Differentiation in Action. *The Roeper School*, 131–144. https://doi.org/10.1007/978-94-6209-419-2_12

Wibowo, H. (2020). *Pengantar Teori-teori belajar dan*

Model-model pembelajaran. Puri cipta media.
Wormeli, R. (2023). *Differentiation: From planning to practice, grades 6-12*. Routledge.