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Attempts to Harness AI Model in Online Differentiated Learning on Students' Understanding Levels

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Abstract

This study aims to examine the relationship between Online Differentiated Learning (ODL), Self-Regulated Learning (SRL), and an Artificial Intelligence Model (AIM) and the Level of Understanding (LU). This study employs an quasi experimental research method, utilizing path analysis as the primary data analysis technique. This study involved 125 respondents who volunteered to participate. The selection of respondents was based on their experience using generative AI applications such as ChatGPT. ChatGPT was used in the study because it is a popular generative AI application. This study found that Online Differentiated Learning (ODL) has an influence on the level of understanding of students. Furthermore, Self-Regulated Learning (SRL) does not affect learning outcomes. Different results are obtained if Artificial Intelligence Model (AIM) is involved to achieve learning outcomes in the form of students' level of understanding. The findings in the study are interesting because the role of AIM influences if integrated in the application of ODL and SRL to achieve learning outcomes. This research is expected to have an impact on the study of artificial intelligence, especially in its implementation in learning. Further research is expected to involve a larger number of respondents with diverse characteristics.

Keywords: Online Differentiated Learning; Self-Regulated Learning; Artificial Intelligence Model; Level of Understanding; Path Analysis

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INTRODUCTION

Online differentiated learning tries to accommodate the diversity of characteristics such as needs, abilities, and preferences that students have in the online learning environment. The diversity of student characteristics is the main focus why differentiated learning is an urgency to be implemented. On the other hand, Artificial Intelligence (AI) technology is currently developing rapidly, especially in the field of education. A study is needed to discuss how AI can play a role in online differentiated learning. Currently, the widely used learning method is the traditional pedagogical method, but in its implementation, the traditional pedagogical method finds difficulty in adjusting effective learning due to individual differences. Traditional pedagogical methods tend to apply the principle of "one size fits all" to serve learners (Rear, 2019; S. Yang et al., 2019). Therefore, traditional pedagogy is considered unsuitable to be applied.

The urgency of meeting the needs of students is one of the considerations why AI technology is needed in learning, especially in the implementation of online differentiated learning. Advances in AI technology have encouraged interest in the world of education to take advantage of it, especially in online differentiated learning. AI allows learners to get a more personalized and adaptive learning experience through customized learning paths and intelligent feedback mechanisms. One of the AI technologies that can be implemented in online differentiated learning includes Large Language Models (LLM), Machine Learning (ML), Natural Language Processing (NLP) and Deep Learning (DL). AI technology is believed to help students to get learning materials that are in accordance with their individual performance, and student preferences.

The use of AI technology in online differentiated learning opens up opportunities to create a more personalized learning experience and increase learning effectiveness. AI's ability to collect learning data related to learning patterns, which is then analyzed in real time, can help to identify cognitive gaps and make appropriate adjustments to learning materials. AI technology in online differentiated learning can help learners to learn at their own pace and complete learning based on the level of difficulty they face. The application of AI technology is certainly not something new, as shown by several previous studies that have discussed how AI can help the learning process (Adamu & Awwalu, 2019; Akgun & Greenhow, 2021; Almaiah et al., 2022; Beketov et al., 2024a; Chaudhry & Kazim, 2022; Delgado et al., 2020). In addition, several other studies only focus on AI technology has a crucial role in providing intelligent learning recommendations and instructions (Zhang & Chen, 2021). AI provides a more personalized learning experience through its ability to analyze in-depth data. In some other previous studies, AI technology only discussed the delivery of learning content, compared to holistic integration with the principles of online differentiated learning.

One of the challenges of using AI in the learning process is the potential for bias in terms of providing recommendations, in addition to privacy and security issues. The potential misuse of data provided by AI can be detrimental to its users. Therefore, the appropriate use of AI is needed, one of which is online differentiated learning. Online differentiated learning can understand and adjust the emotional and social needs of learners. Pegadogis' approach to online differentiated learning accommodates the different characteristics of learners by presenting a unique and personalized experience (Ardiawan et al., 2024; Foo, 2024). AI integration gives teachers the flexibility to design learning strategies by collecting learners' learning patterns. Student learning patterns identify students' weaknesses and strengths to recommend learning materials based on the needs of each student (Haniya & Roberts-Lieb, 2017; Kurniawan et al., 2024). A student who has difficulty in learning will be given recommendations with a different learning flow, while students who have understood certain learning materials will be given more complex challenges to increase learning motivation. In the curriculum development approach, AI is believed to help to design more personalized materials based on diverse needs.

The diverse needs of students are a big challenge in terms of how they affect learning outcomes. Several studies have stated that determining the right learning strategy with the diverse needs of students has a positive influence on learning

outcomes (Allen et al., 2016; Borland, 2012). However, of course, learning strategies that are not supported by high independence are one of the considerations that need to be observed, such as self-regulated learning. Self-regulated learning emphasizes the active role of learners to control and manage their learning flow independently. Self-regulated learning contributes to learning success by offering a variety of adaptive learning resources. The achievement of learning outcomes is a benchmark in the success of the learning process. Several previous studies have shown that students with good self-regulated learning have a greater chance of getting greater learning outcomes compared to students who are otherwise (Calamlam, 2022; Garcia et al., 2018; Harati et al., 2020). This is obvious because of the ability of students to self-regulate, choose learning strategies that suit their preferences, and manage their emotions when facing learning problems. In relation to AI and online differentiated learning, the integration of AI technology encourages a stronger role of self-regulated learning to achieve learning outcomes. AI technology in differentiated learning develops self-regulated learning to tailor learning materials to personal needs and provide feedback. In addition, students have many opportunities to improve self-regulation in learning such as managing learning time, and reflecting on their learning progress independently. However, strengthening self-regulated learning does not go completely well because it requires an awareness of the importance of self-regulation in learning. Therefore, to accommodate the diverse characteristics of students, good self-regulated learning is needed to support the achievement of learning outcomes.

The diverse characteristics of students and the importance of accommodation to meet learning needs are one of the considerations why this research should be conducted. Previous research has discussed the role of AI for more personalized learning through online differentiated learning (Jepkoech, 2023; Mills et al., 2014; Radi & Kadem, 2019; Rijal & Waluyo, 2025; Rintayati et al., 2024). However, currently there is still not much research that discusses the use of AI in online differentiated learning. The integration of AI in online differentiated learning has an impact on learning transformation through learning adjustments based on individual needs. An adequate AI policy and infrastructure is needed to support the implementation of online differentiated learning to improve learning outcomes. To overcome the research problems offered, several research hypotheses are needed:

1. H_1 = Online Differentiated Learning has a direct impact on the Level of Understanding
2. H_2 = Self-Regulated Learning has a direct effect on the Level of Understanding
3. H_3 = Online Differentiated Learning and Self-Regulated Learning through Artificial Intelligence Model have a direct impact on the Level of Understanding

The research hypothesis that has been formulated aims to analyze the influence of online differentiated learning and self-regulated learning both directly and indirectly through artificial intelligence models as mediating variables on the level of understanding. H_1 states that online differentiated learning has a direct influence on the level of understanding, where students get a more personalized learning experience according to their learning needs. H_2 states that self-regulated learning has a direct effect on the level of understanding, where students who have

good self-regulated learning tend to be able to manage learning time. Meanwhile, H_3 states that the Artificial Intelligence Model is believed to be able to help to increase the effectiveness of online differentiated learning through student data analysis and meet learning needs through the learning experiences that have been obtained. In addition, the Artificial intelligence model is able to develop self-regulated learning by providing recommendations for learning materials and feedback.

METHODS

This study uses an quasi experimental research method approach. This research method measures and tests the dependence of online differentiated learning variables in the path analysis model as shown in Figure 1. The pathway analysis model tests the research hypothesis to show both direct and indirect relationships to the variables involved in the study. Online Differentiated Learning (ODL) and Self-Regulated Learning (SRL) as exogenous variables, Artificial Intelligence Model (AIM) as mediation variables and Level of Understanding (LU) as endogenous variables. ODL is measured to assess the differentetiated intructional use in online classes of learners (Roy et al., 2013). Meanwhile, SRL is measured to determine the level of self-control possessed by students during the learning process (Erdogan & Senemoglu, 2016). AIM as a moderation variable measures in-depth competence towards AI literacy (Carolus et al., 2023). Meanwhile, to measure learning outcomes, this study seeks to find out the extent of the level of understanding that students have (X. Yang et al., 2022). The method used in this study is path analysis using IBM AMOS 23.

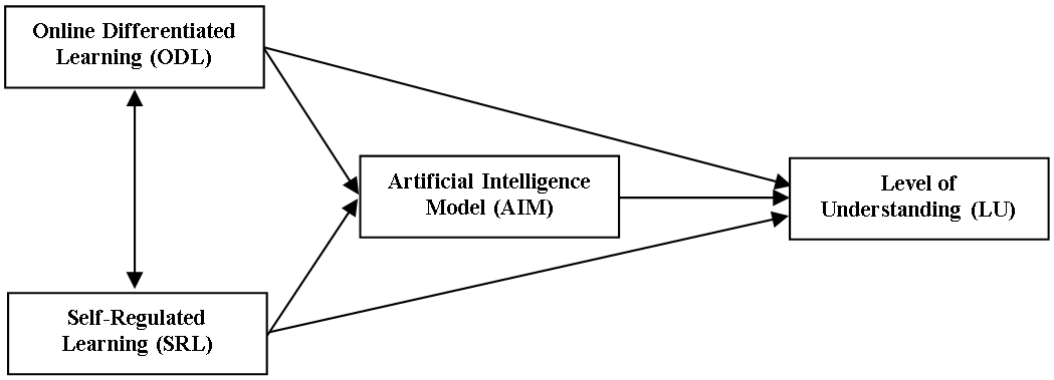

Figure 1. Research design with path analysis

This research uses Large Language Models (LLM) with ChatGPT as one of the Artificial Intelligence Models. The research subjects involved in this study were 125 respondents who were involved voluntarily to fill in research instruments that supported the data collection process. The respondents involved in this research were final year students at a university in Malang, East Java, Indonesia who were completing their final assignments.

The respondents involved in this study had initial skills in using ChatGPT as an Artificial Intelligence platform. The reason for using ChatGPT as a platform is that this platform is quite popular to use compared to other platforms. Students use generative AI, ChatGPT to get learning materials that are appropriate to the level of ability to understand the material. AI Models are used to translate text into a language that learners understand. Meanwhile, the material presented is adjusted to the level of difficulty possessed by the students. Complex texts are simplified to a lower level of comprehension without detracting from the essence of the content presented. Teachers participate to ensure the relevance of the results provided by AI so that they can be accounted for academically.

RESULTS

This study uses path analysis to determine how much influence ODL, SL has on LU and indirectly through AIM. The research model submitted through path analysis is shown in Figure 2.

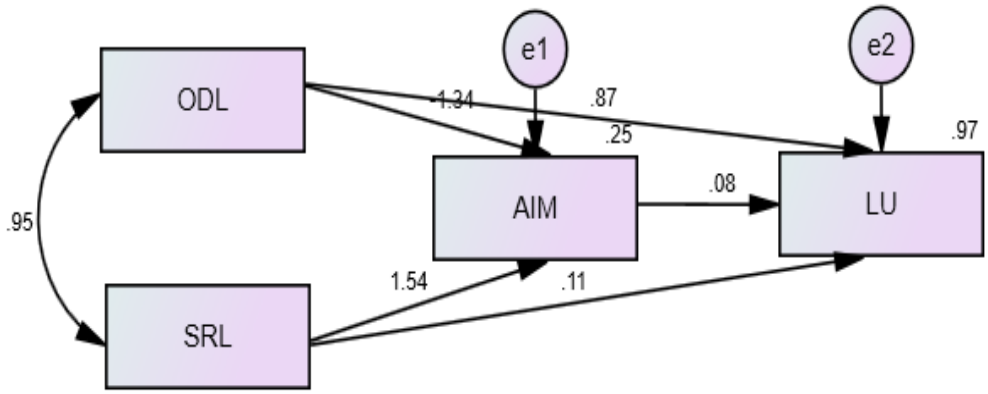

Figure 2. Research model

Figure 2 shows the contribution of influence between exogenous variables, mediation of endogenous variables. ODL as having a positive relationship to AIM of 1.34 so it can be found that ODL can increase AIM. In addition, other exogenous variables, SRL also showed a positive relationship of 1.54 to AIM. AI and SRL make a positive contribution to how self-regulation is used in learning (Beketov et al., 2024b; Harati et al., 2020). The use of AI as a tutor can create more personalized learning by adjusting learning materials based on the characteristics of students. These findings are in line with research that differentiared learning presents a learning flow for students to choose materials according to their preferences (Roy et al., 2013). In addition, differentiated learning offers flexibility for students to start learning through appropriate materials so that diverse learning needs can be met (Kurniawan et al., 2024; Mills et al., 2014; Perkins & Tolbert, 2021). Although ODL and SRL have an influence on AIM, the influence of AIM on learning outcomes is very small, which is 0.08. AI technology provides more personalized learning opportunities, but of course the implementation process requires many supporting factors. Supporting factors in implementing AI are one of the reasons

why AIM can sometimes not have a significant influence on learning outcomes. AI helps learners to be able to improve their self-regulation so that they can organize their own learning process through automated feedback (Chaudhry & Kazim, 2022). Therefore, students have a good level of independence and learning discipline along with the use of AI in the learning process. The results of this study also found that ODL and SRL have a direct influence on learning outcomes in the form of students' level of understanding. The use of AI in learning and its relation to SRL requires several aspects, namely the activeness and position of students (Jin et al., 2023). The application of the research model in Figure 2 is of course related to the research data of 125 respondents' who met the normality requirements as shown in Table 1.

Table 1. Normality of research data

Variable	min	Max	skew	c.r.	kurtosis	c.r.
SRL	62.000	78.000	-.062	-.285	-1.075	-2.453
ODL	70.000	81.000	.135	.617	-.226	-.515
AIM	73.000	84.000	.096	.439	-.270	-.617
LU	82.000	93.000	.105	.481	-.008	-.017
Multivariate					.319	.257

Table 1 shows the normality of the data by comparing the critical ratio (c.r) value with the critical value ± 2.58 at the level of 0.01. The c.r value of the variables involved in this study met the requirements of a univariate normal distribution. In addition, Table 1 shows that the research data meets the normality test univariate because the critical ratio (c.r) value of both skew and kurtosis, in the range of ± 2.58, and is also distributed normally multivariate because the c.r value of 0.257 is in the range of ± 2.58. This study found several hypothesis tests that will be proven as shown in Table 2. Table 2 shows how ODL has a direct effect on LU, but SRL does not have an effect on LU. In addition, AIM has an influence on LU as a learning outcome.

Table 2. Model Estimation Interpretation

Hypothesis	Standardized Regression Weight	c.r.	P	Hypothesis Test
ODL →AIM	-1.336	-5.371	0.001	There is an influence
SRL→ AIM	1.540	6.194	0.001	There is an influence
AIM→LU	0.081	4.440	0.001	There is an influence
ALC→LU	0.869	15.593	0.001	There is an influence
SRL→LU	0.105	1.829	0.067	No influence

Table 2 in the ODL section → AIM has a negative influence on the influence of Differentiated Learning (ODL) on Artificial Intelligence Model (AIM), indicating that increasing ODL can decrease AIM, although the relationship between the two is significant. This could occur because AIM can work independently. On the other hand, SRL has a positive and significant influence on AIM. This indicates that the better the level of SRL possessed by students, the more optimal the utilization of AIM.

Discussion

Table 2 shows evidence of the following 3 research hypotheses:

a. Online Differentiated Learning (ODL) on Level of Understanding (LU)

The Standardized Regression Weight coefficient was obtained as 0.869 with a c.r value of 15.593, which shows that there is a positive relationship between ODL and LU. The implementation of ODL is believed to increase the level of understanding possessed by students. Hypothesis testing shows that the probability value is 0.0001 ($P<0.05$) so that the results of the study prove that H_1, Online Differentiated Learning (ODL) has an effect on the Level of Understanding (LU). The results of the study show that Online Differentiated Learning (ODL) can improve students' understanding, which is in line with previous research which states that students more easily achieve conceptual understanding as the differentiation theory supports students in being able to choose learning materials and learning paths that suit their learning styles, needs and preferences (Jepkoech, 2023; Kurniawan et al., 2024). These findings certainly also support differentiated learning in online learning. Online differentiated learning provides a solution by offering a Choice-based Instruction (CBI) model that allows students to choose learning paths based on their interests and needs. This CBI model leverages the power of technology to support differentiated learning. The role of Online Differentiated Learning (ODL) can strengthen more personalized learning (Haniya & Roberts-Lieb, 2017). The implementation of ODL provides diverse learning opportunities for students so that they feel facilitated in learning based on their needs and characteristics, and ultimately impacts learning outcomes.

b. Self-Regulated Learning on Level of Understanding

The results of the study showed a difference from the initial assumption regarding the relationship between Self-Regulated Learning (SRL) and Level of Understanding or refuted the second hypothesis, where the study found that SRL had no effect on students' level of understanding, which was shown by a probability value of 0.067 ($P>0.05$). Although it has not been able to show a significant influence of SRL and is not strong enough to influence the level of student understanding, SRL can play a role as a skill factor that can regulate the learning process independently as shown by the relationship coefficient value of 0.105 with a c.r value of 1.829 ($P>0.05$). The results of this study support the SRL theory that SRL requires external factors such as learning motivation and technological scaffolding in learning to have a greater impact on learning outcomes (Han et al., 2025; Jin et al., 2023; Schunk & Zimmerman, 2012). This indicates that SRL capabilities independently may not necessarily result in better understanding if not supported by external factors, which means that SRL can provide optimal contributions if supported by appropriate technology and learning strategies.

c. Online Differentiated Learning (ODL) and Self-Regulated Learning (SRL) through Artificial Intelligence Model (AIM) towards Level of Understanding (LU)

AIM affects the level of understanding of students (LU) but this does not affect SRL to LU. On the other hand, ODL and AIM have been shown to affect LU. AI

is an important concern in the learning process through its ability to make learning more personalized. AI in learning is very important to provide recommendations on materials and learning flows to students (Cheng et al., 2022). Previous research has shown that AI can provide recommendations based on the learning experiences that learners have. The learning experience possessed by students can be in the form of performance, learning needs and preferences that students have obtained. In addition, AI users are believed to be able to improve SRL to achieve a level of understanding in learning. SRL provides opportunities for students to manage learning strategies independently through recommendations provided by AI. There is a relationship between SRL and learning outcomes, but SRL cannot automatically improve learning outcomes because other supporting factors are needed such as learning motivation (Schunk & Zimmerman, 2012). SRL in the learning process with AI increases the potential for more personalized data analysis, and supports learners to organize their learning through the use of technology (Molenaar et al., 2023).

The findings of this study are interesting because SRL, which is usually believed to affect research results, found that SRL does not have a significant effect if it does not involve AI in learning. On the other hand, these findings confirm that AI plays an important role in the learning process such as the learning adaptation process and the personalization process. In addition, AI provides convenience not only to students but also to teachers in terms of the process of analyzing student development and to adjust the right differentiation method (Abbasi et al., 2025; Akgun & Greenhow, 2021). Artificial intelligence models have the ability to collect data in the form of learners' learning patterns based on their diverse characteristics, and provide data-based recommendations to develop more accurate differentiated learning strategies. The combination of online differentiated learning, self-regulated learning and artificial intelligence is believed to help learning to accommodate learning needs.

CONCLUSION

This study provides the findings that Online Differentiated Learning (ODL) has an influence on learning outcomes in the form of students' level of understanding. However, different results found that Self-Regulated Learning (SRL) did not have an effect on learning outcomes. Different results are obtained if the Artificial Intelligence Model (AIM) is involved to achieve learning outcomes in the form of students' level of understanding, AIM involvement encourages students to improve self-regulation so that they can determine learning outcomes more personally and independently. This study is limited by the relatively small number of respondents, making it impossible to generalize the results to future research. Furthermore, it did not fully explore student engagement and readiness in using artificial intelligence technology. Future research is expected to incorporate several factors, such as student readiness and engagement, and a larger number of respondents. The results of this study are expected to add a study on the application of AI technology in learning and what factors need to be considered. Further studies

that can be considered to test the effectiveness of AI integration in different learning strategies to see the extent of consistency of the findings in this study.

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