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The TaRL Approach as a Driver of Technological Innovation in Mathematics Learning in Senior High Schools/Vocational High Schools

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Abstract—The Industrial Revolution 4.0 demands that the world of education adapt to technological developments. In mathematics learning in high schools/vocational schools, the use of technology and appropriate learning approaches to improve the quality of education is very important. The Teaching at the Right Level (TaRL) approach, which adjusts teaching to the level of individual student ability, is considered relevant to create a more effective and efficient learning process. This study aims to examine the role of the TaRL approach as a driver of technological innovation in mathematics learning at the high school/vocational school level. The method used is a literature review by reviewing 10 articles related to the research topic. The results and discussion of the study explain that the integration of TaRL with technology, such as GeoGebra software, Google Sites, and other digital devices can improve students' understanding of mathematical concepts, critical thinking skills, and learning motivation. This approach also supports inclusive learning that is relevant to the needs of the digital era. However, on the other hand, there are challenges that arise including limited teacher competence in the use of

technology and gaps in access to digital infrastructure. This can affect the effectiveness of the implementation of the technology-based TaRL approach. Thus, intensive training for educators and increased access to infrastructure are needed to support optimal implementation. This approach is expected to inspire educators in creating more adaptive, innovative, and future-oriented learning.

Keywords— *Technology Innovation; Mathematics Learning; High School/Vocational High School; Teaching at the Right Level (TaRL)*

I. INTRODUCTION

In the era of the Industrial Revolution 4.0, education is required to adapt to rapid technological developments. Mathematics, as one of the fundamental subjects, plays an important role in equipping students with essential analytical thinking and problem-solving skills. Therefore, innovation in mathematics learning is crucial to improve students' understanding and interest in the material being taught.[1]

One approach that has emerged to address this challenge is Teaching at the Right Level (TaRL). TaRL is a method that adapts learning to the individual student's ability level, not based on age or grade. This approach aims to ensure that each student receives material that is appropriate to their understanding, so that the learning process becomes more effective and efficient.[2]

The integration of technology in mathematics learning further enriches teaching methods. The use of simulation software, educational games, and online platforms can increase the interactivity and attractiveness of learning. This is in line with the TaRL principle which focuses on the individual needs of students, allowing for the adjustment of materials through technology according to their respective abilities.[3]

The application of TaRL in mathematics learning at the high school/vocational school level in Indonesia has shown positive results. Research shows that this approach is able to increase student learning activity, especially in mathematics subjects. By designing learning that is appropriate to the level of student ability, TaRL helps overcome the problem of low participation and learning motivation.[4]

In addition, project-based mathematics learning innovation is also an effective method. In this approach, students are given project tasks that involve the application of mathematical concepts in real contexts, so that they can understand the relevance of the material being studied to everyday life..

However, challenges in implementing TaRL and technological innovation in mathematics learning remain. Limited teacher skills in integrating technology, gaps in access to digital devices, and resistance to changes in teaching methods are some of the obstacles that need to be overcome.[5] Therefore, training and professional development for teachers is the key to the successful implementation of this approach.

Thus, the TaRL approach combined with technological innovation offers great potential in improving the quality of mathematics learning in high schools/vocational schools. Through the adjustment of materials according to students' ability levels and the use of technology, it is hoped that the learning process will be more interesting, interactive, and effective, so that it can produce graduates who are ready to face challenges in the digital era.[6]

Based on the background above, researchers are interested in conducting research on "The TaRL Approach as a Driver of Technological Innovation in Mathematics Learning in Senior High Schools/Vocational High Schools". The purpose of this study is to examine the role of the TaRL approach as a driver of technological innovation in mathematics learning in Senior High Schools/Vocational High Schools from several research results. Thus, it is hoped that this research can provide innovation in the application of an effective approach in mathematics learning at the Senior High School/Vocational High School level by integrating digital technology.

II. METHOD

This research uses a literature review approach, which is one method used to analyze various previous studies that are directly relevant to the topic being investigated. A literature review is the activity of reviewing various literature that is relevant to the topic to be researched [7]. A literature review is an activity of examining or analyzing various literatures that have been published by academics or researchers that are relevant to the topic to be studied [8]. The researcher does not conduct experiments or collect data directly. This approach aims to conduct a deeper analysis of the Teaching at the Right Level (TaRL) approach as a driver of technological innovation in mathematics education at high school/vocational school level.

Compiling a good literature review requires paying attention to five stages in the preparation and writing process, namely finding relevant studies, evaluating literature review sources by identifying research questions and problems, identifying existing theories and real conditions in the field, determining criteria that must be met. article and create an outline structure, and compose a review [9]. According to [10] preparing a literature review includes selecting a topic, searching for literature, developing arguments, and writing a literature review. This research will use three stages according to [11] which consist of determining the topic and formulating research questions, collecting and evaluating relevant literature, and compiling and presenting the results of the literature review. A good literature review not only summarizes previous research, but also critically evaluates and synthesizes that work [12].

The first step in carrying out a literature review is to determine relevant topics and formulate specific research questions so that the scope of the literature review can be clearly defined. Literature review includes the process of collecting, organizing, and assessing writings that are relevant to the research topic being discussed [13]. After that, researchers must establish clear criteria for selecting articles that will be used as references in the study. The criteria that literature must fulfill in order to be included in the study, namely the publication period spanning 2021 to 2024 and the relevance of the topic regarding the Teaching at the Right Level (TaRL) approach as a driver of technological innovation in mathematics learning at high school/vocational school level.

After establishing the criteria, the next step is to collect and evaluate the literature. Researchers use Google Scholar to search for articles that match the research topic. The articles found are then evaluated based on their quality, methodology used, and their contribution to the development of the research field [11]. The final stage is the preparation and presentation of the results of the literature review. At this stage, the results of the literature review are prepared systematically and in detail to provide a comprehensive understanding of the topic discussed, reveal deficiencies in existing research, and formulate recommendations for further research development. Integrated literature reviews are considered important as a method for combining various literatures to create new perspectives in a research field [14].

III. RESULTS AND DISCUSSION

The Teaching at the Right Level (TaRL) approach combined with technological innovation has enormous potential to improve the quality of mathematics learning in SMA/SMK. By adjusting learning materials according to the ability level of students and utilizing technology, it is expected that the learning process will become more interesting, interactive, and effective, resulting in graduates who are ready to face challenges in the digital era.

In this study, researchers have analyzed ten scientific articles from Google Scholar with the keywords “Teaching at the Right Level (TaRL)”, “technology”, “mathematics learning”, and “SMA/SMK” in the 2021-2024 time span. The results of the analysis are presented in Table 1.

TABLE 1. RESEARCH ANALYSIS RESULTS

No.	Name and Year	Title	Research Results	Link
1.	Muhammad Rinov Cuhazria nsyah, Yuniana Cahyaningrum, Nurlita Abelianiti (2023)[15]	“Collaborative Learning through Teaching at the Right Level (TaRL) Approach and Application of Problem Based Learning (PBL) Model in an effort to Improve Student Learning Outcomes at Vocational High Schools”	The collaboration of the Problem Based Learning (PBL) model with the Teaching at the Right Level (TaRL) approach on vocational learning materials can improve student learning outcomes.	https://prosidingsikippgribojonegoro.ac.id/index.php/FPMIPA/article/view/2186
2.	Suci Meidhita Widiastuti, Lilik Ariyanto, Bayu Wardani (2023)[16]	“Application of PBL Model with TaRL Approach Assisted by GeoGebra to Improve Problem Solving Ability of Vocational Students”	Learning by applying the PBL model with the TaRL approach assisted by GeoGebra can improve the problem solving skills of students in class XII KGS 3 SMK Negeri 7 Semarang in the 2023/2024 academic year.	https://conference.upgris.ac.id/index.php/psnpg/article/download/5294/4099
3.	Fenny Rofiatul Khoififah, Lady Agustina, Aniek Susi Rahayu (2024) [17]	“Improving Student Learning Outcomes Using the TaRL Approach in Engineering Class XI 2 Students”	More varied and inclusive learning activities, the use of interactive learning media, and special attention to students' cultural backgrounds have proven effective in improving learning outcomes. The Teaching at the Right Level (TaRL) approach not only makes learning more	https://ejournal.unipma.ac.id/index.php/JEMS/article/view/21020

			interesting and relevant for students, but also helps them see the connection between the subject matter and their daily lives. This increases their motivation to learn and actively participate in the learning process. Thus, Teaching at the Right Level (TaRL) approach can be considered as an effective strategy to improve students' learning outcomes and engagement in mathematics learning.	
4.	Kiki Novita Sari, Rizky Esti Utami, Ami Ariyani, Rasiman (2024)[18]	“Application of TaRL-based PBL-Flipped Classroom with Google Sites to Improve Students' Numeracy Literacy”	The implementation of TaRL-based PBL-Flipped Classroom model with the help of Google Sites not only improves students' numeracy literacy, but also develops important technological skills for them. This learning model is proven to be effective in preparing students to face the demands of education and employment in the future. This research provides strong evidence that the integration of technology and student-centered learning approaches can lead to better learning outcomes.	https://conference.upgris.ac.id/index.php/psnpg/article/view/5861
5	Mauliddha Rachmi, Nugroho Dwi Susanto, Hanna Arini Parhusip, Fika Widya Pratama (2024) [19]	“Teaching at the Right Level in Digital-based PBL Model to Improve Mathematics Learning Outcomes and Mental Health of Vocational Students”	Analysis of the increase in mathematics learning outcomes and mental health of pre-cycle - cycle I - cycle II students has met both indicators of success, it is concluded that the PBL learning model with a digital-based TaRL approach can improve mathematics learning outcomes and mental health of students in class X-AKL-2 SMK Negeri 1 Salatiga.	https://www.jonedu.org/index.php/jonedu/article/view/6154
6.	Mailly Paiticen,	“Improving Students'	The application of the TARK approach	https://proceeding.

	Retno Mujiastuti, Ani Rusilowati (2024)[20]	Science Literacy Using the TARL Approach by Assisted by E-LKPD at SMPN 24 Semarang	aided by E-LKPD can improve students' science literacy in class VIII science learning at SMP N 24 Semarang with an n-gain value of 0.61. The aspect of science literacy that has the highest increase is in evaluating and designing scientific research with an n-gain of 0.65.	unnes.ac.id/snpptk/article/view/3239
7.	Enggar Tri Astuti, Restu Lusiana, Musta'in Musta'in. (2024)[21]	"Application of Teaching at the Right Level (TaRL) Approach to Increase Student Learning Activity in Class X Mathematics Subjects"	Grouping students based on ability levels provides opportunities for all students to succeed according to their respective abilities. The changes and developments made are an effort to overcome the low student activeness in the learning process.	https://jurnal.ciptamediaharmoni.id/index.php/ptk/article/view/455
8.	Nur Afiani Herniatsih, Nur Zamroni, Endang Retno Winarti (2024)[22]	"Improving Students' Critical Thinking Ability Using PBL Model with TaRL Approach Assisted by Geogebra on Function Material and Its Modeling Class XI SMAN 12 Semarang"	The critical thinking skills of students of XI F.2 SMAN 12 Semarang increased after 3 cycles of learning by applying the PBL model of TaRL approach assisted by Geogebra on the material of function and its modeling. In addition, based on the results of observations showed that changes in student attitudes in learning became better in each cycle.	https://proceeding.unnes.ac.id/wpcgp/article/view/3465
9.	Dwi Rani Prihandini, Siti Alfiyana Azizah, Isma Atikah (2023)[23]	"Synergy between Differentiated Learning Implementation and Teaching at the Right Level in Presenting an Inclusive Learning Environment"	The implementation of differentiated learning with the TaRL (Teaching at the Right Level) approach has a positive impact on learning. This is because differentiated learning with the TaRL approach can facilitate learners' learning participation. Learners more easily understand what they learn according to their ability level. The implementation of differentiated learning with the TaRL (Teaching at the Right Level)	https://edupubmedia.id/index.php/jtp/article/view/76/94

			approach is one of the efforts in creating an inclusive learning environment and responsive to the learning needs of learners.	
10.	Fahmi Arif Falakhudin, Sc. Mariani, Dewi Sulandari (2024)[24]	"Improving Problem Solving Ability Using Problem Based Learning Model in Class XI SMA Negeri 5 Semarang"	There is an increase in students' mathematical problem solving ability on function material and its modeling by using Problem Based Learning with the Teaching at the Right Level approach.	https://proceeding.unnes.ac.id/wpcgp/article/view/3414
11.	D. Chacon-Hurtado, K. Kazerounian, S. Hertel, J. Mellor, J. J. Barry, and T. Ravindran (2024)[25]	"Engineering for Human Rights: The Theory and Practice of a Human Rights-based Approach to Engineering"	A human rights-based approach to engineering offers the advantage of a broader range of goals, integration with existing ethics, and opportunities for new innovation. Based on principles of fairness, participation, accountability, and inalienable rights, this paradigm is not only consistent with the concept of social justice in engineering, but also has the potential to transform education, professional practice, and its impact on society.	https://journals.sagepub.com/doi/full/10.1177/01622439231211112

Based on Table 1 above, the Teaching at the Right Level (TaRL) approach can adjust learning materials to the ability level of learners. With this adjustment, students get material that is in accordance with their understanding, so they can carry out learning effectively. Research by Cuhanaazriansyah, et al. [15] proved that combining the Problem Based Learning (PBL) model with Teaching at the Right Level (TaRL) can improve student learning outcomes in vocational learning materials.

In addition, technology plays an important role in the Teaching at the Right Level (TaRL) approach which can make the learning process more interactive. Research by Widiastuti, et al. [16] showed that the application of the Problem Based Learning (PBL) model with the help of GeoGebra in the Teaching at the Right Level (TaRL) approach can improve problem solving skills in students. GeoGebra is an example of technology that can help students understand math concepts well [26].

The Teaching at the Right Level (TaRL) approach can also be combined with various existing learning models such as Problem Based Learning (PBL) and Flipped Classroom so as to create a diverse and inclusive learning environment for

students. Sari, et al. [18] suggested that the PBL- Flipped Classroom model based on TaRL with the help of Google Sites not only improves learners' numeracy literacy, but can improve technological skills which are very important for their future.

With the suitability of learning materials and the use of technology can make learning more relevant and interesting for students, so that it can increase student motivation [27]. Khofifah, et al. [17] stated that the TaRL approach helps students in understanding the relationship between subject matter and examples in their daily lives, thus increasing motivation to learn and play an active role during learning. In addition, this study showed that the TaRL approach combined with technology can significantly improve students' learning outcomes. For example, Rachmi, et al. [19] proved that the PBL learning model with a digital-based TaRL approach can improve students' math learning outcomes and mental health.

The integration of technology in the TaRL approach can help learners prepare for the challenges of the digital era. The use of technology in learning not only improves learning outcomes but also skills in the use of technology that are important for learners in the future. Research by Sari, et al. [18] shows that the PBL- Flipped Classroom model based on TaRL with the help of Google Sites helps learners to prepare for education and work in the future.

IV. CONCLUSIONS

Based on the results of the literature review on the technology-integrated TaRL approach in mathematics learning, it can be concluded that from the 10 articles analyzed, the TaRL approach is effective in adjusting learning materials to the level of student ability. This adjustment has an impact on increasing the efficiency and success of the learning process. The application of TaRL combined with the Problem Based Learning (PBL) or Flipped Classroom learning model can improve learning outcomes, problem-solving skills, and numeracy literacy of students.

The use of technology, such as Geogebra and Google site, in the TaRL approach contributes to more interactive, relevant, and interesting learning. This approach not only increases students' learning motivation, but also hones students' skills in using technology, which is an important provision in the digital era. The integration of TaRL with technology has been proven to support the connection between learning materials and everyday life, create an inclusive learning environment, and improve students' mental health. Thus, the TaRL approach combined with technology and other learning models is an innovative solution to create a more meaningful, inclusive learning experience and prepare students for a better future.

It must be admitted, this study also has several limitations, including the data collection technique using the Google Scholar database with a span of 2021 to 2024 has limitations because the database cannot distinguish between quality manuscripts and general manuscripts. For further studies, it can be done with a more detailed theme, of course, it can enrich the understanding of the integration of the integrated TaRL approach with digital technology.

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