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Development of Project Based Learning With STEAM Approach Model in Improving the Science Literacy Ability of High School Students 4

Nuraini*, Nurul Fajri, Indra Himayatul Asri, Edy Waluyo Department of Biology Education, FMIPA,

Universitas Hamzanwadi Jln . Tgk. H. **M. Zainuddin Abdul Majid No. 132 Pancor, Selong Lombok Timur** , Nusa Tenggara Barat, **Indonesia** *Email: nurainiedy76@ **gmail.com** 21

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. Abstract. Facing today's 21st century learning, teachers need to foster science literacy and consider learning strategies that are appropriate to the conditions and potential of learners. This study aims to develop a PjBL with STEAM approach model in improving science literacy ability of high school students. This study is a development research with the Borg & Gall development model. The sample of this study was class X students of SMAN 2 Selong, totaling 35 students. The instruments used to collect data include guidelines for validating learning design, practicality questionnaires and science literacy ability tests on ecosystem materials. The data analysis used in this study used descriptive analysis. Based on the validation analysis, the products developed are included in the valid category indicated by the average score of product validation by 3 experts, namely linguists, material experts and learning technology experts successively 83.91; 84.64 and 83.73. Similarly, in terms of practicality, the products developed are also classified as practical with an average practicality score of 82.63. The product is also classified as effective with a percentage of effectiveness of 88.57%. The product developed has a potential effect in the high category to improve science literacy ability on ecosystem materials with an N-Gain of 0.76. Keywords: STEAM, Project Based Learning, Science Literacy Introduction The learning of

the 21st century is characterized **by the** rapid **development of science and technology in the** sphere **of life in society, especially information and communication technology** 15

. Currently, the world community is entering a new era, an era of accelerating changes in various aspects or fields including education. The demands of the 21st century make the education system must be in accordance with the changing times. Science

literacy is very important for students to have as a provision to face the challenges of the development of the **21st century** 1

. Science literacy directly correlates

with building a **new** generation **that** has **strong** scientific **thoughts and attitudes that can** effectively **communicate** science **and research results to the general public** 1

. Based on PISA 2019, the science

literacy ability of Indonesian students is still below average when compared to the average **international** 24

yaitu peringkat 70 dari 78 negara (Mullis, 2019). The results of the 2019 PISA study are proof that Indonesian formal education Nuraini, et al.: Development of Project Based Learning With STEAM Approach Model.....| 639 emphasizes more on the aspects of low-level thinking and rarely accustoms students to use higher-order thinking in facing and solving real problems in everyday life (Durden, 2018).

Facing today's 21st century learning, teachers need to cultivate **science literacy and** 13

consider learning strategies that are in accordance with the conditions and potentials **of students** where **the learning process focuses on providing** hands-on **experience and** applying **the** nature **of science** 14

. Literacy skills are fundamental things

that must be possessed by students in facing the global era to be able to meet the needs of life in various situations. Science literacy is the ability to understand science, communicate science, and apply science skills **to solve problems** 8

.

Science literacy can be defined **as scientific knowledge and** skills **to be able to identify questions, acquire new knowledge, explain scientific phenomena, and take conclusions based on facts, understand the** characteristics **of science, awareness of how science and technology shape the natural, intellectual, and cultural environment, as well as the willingness to engage and care about issues related to science** 5

(OECD, 2019). A person has science

and technology literacy **characterized by having the ability to solve problems by using** science **concepts obtained in education** according to their **level, getting to know the** 17

technological products

around them and their impacts, being able to use technological products and maintaining them , being **creative in making simplified technological results so that students are able to make decisions based on** community **values and culture** 11

(Nunaki et al., 2019). The main elements contained in science literacy according to (Harlen, 2004), 1)

concepts or ideas, which help understanding of scientific aspects of the world around and which enable us to make sense of new experiences by linking them to what we already know , 2). **processes, which are mental and physical skills used in obtaining, interpreting and using evidence about the world around to gain knowledge and build understanding** , 3). **attitudes or dispositions, which indicate willingness and confidence to engage in enquiry, debate and further learning** 3

, 4). understanding the nature (and limitations) of scientific knowledge. With science literacy, students can have sensitivity in solving global problems, able to meet the various demands of the times, namely becoming competitive, innovative, collaborative, and characterful students. The learning carried out by the teacher will affect the learning atmosphere carried out (Kilinc, 2018).

Teachers need to design and manage learning by actively engaging **students in** 36

learning that encourages students to learn (Mbhiza, 2021; Öztürk, 2020; Tsakeni, 2021). Project based learning (PjBL) gives teachers the opportunity to manage classroom learning by involving project work (Acar et al., 2018). PjBL is student-centered and gives students the opportunity to conduct in-depth investigations on essential topics (Yamin et al., 2020). PjBL is an activity where students can access knowledge and the teacher facilitates students in conducting investigations (Ramesh, 2020). PjBL requires students to design and develop systems that can be used to conduct investigations and solutions to real-world problems (Sababha, 2016). PjBL

is a method in which students engage in intellectually challenging task **tasks** 28

to gain knowledge and skills used in solving problems (Movahedzadeh, 2012). PjBL provides a structure for students to engage in every practice by taking steps to develop and implement projects (Baker, 2004). PjBL is a complex activity

based on challenging problems that engages **students in** project **design** and **problem solving** 39

and provides opportunities for students to work independently (Fitriyani, 2018). PjBL is an effective learning to develop students' science literacy skills (Tasiwan, 2015). Students who perform PjBL activities will have more significant learning outcomes than those who use regular learning as usual (Çakici, 2013). PjBL provides opportunities for teachers to motivate students to develop the right strategies, design projects and make research in solving real problems faced. 640|

can make students more critical, investigative, communicative and interactive in conducting experiments (Farida, 2017). PjBL emphasizes the interrelationship between concepts and the child's daily experiences so that students can relate concepts they already have with the new knowledge they have gained. Characteristics of PjBL according to Kosasih (2014), 1) the existence of activities that produce products or works, 2) the concept of learning materials is connected to daily life, 3) learning can be carried out in the classroom or outside the classroom, 4) students design the activities or products produced, 5) assessments are carried out from planning activities, processes to results. Tiantong (2013), in his research, he mentioned that PjBL is effective for improving

student learning outcomes. Through project-based learning students can gain more active knowledge, and students are more responsible in the learning process.

The challenge of an educator is to provide an educational **system that creates opportunities for** learners **to connect knowledge and skills** 19

. Opportunities will not be created if knowledge and skills are separated in a learning process. Pfeiffer (2013)

states that in STEAM **learning skills and knowledge are used simultaneously by** learners. **Students** 25

are expected to be able to have the ability to live as individuals and citizens who are faithful, productive, and able to contribute to their lives. STEAM based learning approach that offers meta-disciplinary education in developing thinking skills and creativity in solving problems. STEAM as an integration of the discipline of art

into the curriculum and learning in the areas of science, technology, engineering and mathematics (Buonincontro, 2018). **STEAM is a meta-discipline** 6

in which

teachers of science, technology, engineering and mathematics teach an integrated approach and each disciplinary **material is not divided but handled and treated as a dynamic** 6

whole (Mariale, 2019). Based on the description above, this study aims to develop PjBL

with STEAM approach model in improving the science literacy skills **of high school students in** 23

East Lombok. Methods The type of research used Borg & Gall model with

steps 1) needs analysis, 2) product design, 3) product development, 4) product implementation and **evaluation** (Borg & Gall, 2007). 22
The

needs analysis was carried out by open interviews with biology teachers and providing questionnaires to students about students' feelings in participating in learning by biology teachers. The interview with the biology teacher related to the learning strategy used consists of 5 questions. The questionnaire about students' feelings after attending the lesson consisted of 15 questions. The test subjects of this study were class X of SMAN 2 Selong, East Lombok with a total of 35 students consisting of 10 male and 25 female who were taken by

random sampling. The research **instruments used in this** study **include 1**) guidelines for **validation** of learning products, 31
2

) guidelines for the practicality of learning implementation, and 3) learning outcomes tests on ecosystem materials. The learning product validation guidelines developed contain measurement indicators, including: 1) indicators of goal formulation, 2) content indicators, 3) indicators of the language used, and 4) indicators of time. Meanwhile, the guidelines for the practicality of implementing the developed Nuraini, et al.: Development of Project Based Learning With STEAM Approach Model.....|641 product contain indicators of 1) students' feelings of pleasure in the learning process, 2) assessment of the novelty of the

product developed in learning, 3) student interest in participating in learning using the developed product. The learning outcomes test instrument on ecosystem materials is an essay test with indicators: 1) explain the facts and concepts, 2) presenting hypotheses, 3) answering questions related to science information. Meanwhile, the product

is validated by 3 experts, namely material experts, learning technology experts, and linguists. To obtain a valid, practical, and effective product, field trials are carried out. The quality of the development product in the form of a learning design PjBL with STEAM approach model is measured based on product validity, product practicality and product effectiveness. Product validation indicators are presented in Table 1. Table 1. Expert Developed Product Validation Guidelines Aspects Indicators Conformity The level of conformity of the learning design with the mod- el developed with the basic competencies and indicators of competency achievement in the curriculum Ease The language used in developing products with a level of understanding is difficult, moderate or easy by the teacher. Completeness Completeness of materials and variations in learning Clarity Clarity of description and systematic arrangement of the material in the learning model The product developed in the form of PjBL with STEAM approach in improving science literacy ability is said to be valid if the product developed is in accordance with each aspect with indicators set for each aspect. The validity criteria of the learning model developed using criteria such as Table 2. Table 2. Learning Model Validity Criteria Interval Score 85 70 45 x < 45 Validity Criteria Very valid Valid Quite Valid Less Valid The practicality of the product developed in the form of a learning design with a PjBL with STEAM approach is tested based on 1) an assessment of the practicality of the product by experts, 2) the magnitude of the teacher's response after carrying out learning with a PjBL with STEAM approach in improving science literacy ability with criteria such as Table 3. 642|

Learning Models Interval Score Practicality Criteria 85 Very Practical 70 Practical 45 Quite Practical x < 45 Less Practical Meanwhile, to test the effectiveness of the products developed in improving science literacy ability is carried out by analyzing the scores of science literacy ability test results after getting learning. The indicator of product effectiveness set is that at least 85% of all students who take the ecosystem material learning outcomes

products that have been developed in improving student learning outcomes, it is carried out by calculating the N-Gain value by calculating the difference between postes scores and pretests of student learning outcomes on ecosystem materials. Results and Discussion Needs Analysis Before conducting research as a basis for developing products, researchers conducted a needs analysis by conducting interviews with biology teachers high school related to the application of the learning strategies used and providing questionnaires to students about students' feelings after participating in biology learning.

learning process carried out is still conventional and not student-centered, the teacher's dominance in learning is very high, students' thinking ability has not been developed adequately and the teacher provides more examples and practice questions, 2) In learning, teachers have not carried out variations in learning and have not taken advantage of real problems, 3) In learning, schools need to prepare supporting facilities related to the use of technology and an adequate internet network in integrating technology in learning, 4) Teachers expect support from schools to improve their knowledge of innovative learning as part of the competencies needed in implementing current learning. Meanwhile, based on the questionnaire given to 35 students of class X Senior High School on the learning carried out by biology teachers, it showed that 1) the learning obtained was generally not fun, boring, and monotonous with a percentage of 75%, 2) in learning, the teacher's efforts to develop students' thinking skills are not optimal so that students are confused when facing non-routine questions, which require the ability to think in solving the problems faced, 3) In learning, teachers and students have not utilized adequate technology as the demands of 21st century learning today because the availability of technology needed in learning in schools is still lacking with a percentage of 80%, 4) In learning, teachers have not used innovative and varied learning strategies so that learning is momoton with a percentage of 75%. Referring to the needs analysis above, Nuraini, et al.: Development of Project Based Learning With STEAM Approach Model.....|643 is necessary to develop a learning model that is able to develop

students' thinking abilities by actively involving students in learning so that two-way interaction in learning can be carried out. Product Design Stage The development product is in the form of an integrated PjBL instructional design of science literacy. Products are developed according to the stages of learning activities that refer to the integrated PjBL model of science literacy, namely: 1) starting with important questions, taking topics that correspond to real-world reality and starting with investigations using students' science skills, 2) project work planning, and selection of activities related to science skills in answering important questions, 3) drawing up a schedule of activities, 4) monitor the progress of student projects, 5) assessment of student project outcomes, 6) evaluation of student learning experiences. This step is in line with the research Muskania & Wilujeng (2017) that the learning of the project begins by providing

problems that lead to the final product to **be produced by the** 9

student. After brainstorming, the next step students are given the task of creating and designing projects. During the design of the project, students are directed to search for valid and scientific-like literature and sources. Collaborating with the team during project learning is of utmost importance.

Collaboration is one of the characteristics of project learning activities **with the aim of helping students** to **exchange ideas and** 9

have good communication skills. Meanwhile, Astawa, (2017)

explained that the PjBL **stage trains students to** become **active and** creative thinkers **and** engage **in** 9

cooperative learning to work together. Product Development and Evaluation Stage The product draft developed was validated by 3 experts, namely learning material experts, learning technology experts and learning practitioners. Expert validation is performed to get feedback, suggestions, comments, and corrections to the initial product for further improvement to improve the product. Based on the results of the validity analysis, a product validity score is obtained as presented in Table 4. Table 4. Validation Results of Developed Products Component Validation Results Material Expert Technologist Linguist Identity 92 Formulation of Indicators 81 Goal Formulation 85 Material suitability 80 Preliminary Activities 80 Core Activities 82 Learning Activities 85 Learning Resources 87 Evaluation 85 Closing 84 Language Use 82 Average Score 83,91 Conclusion Valid 90 79 80 82 85 85 87 86 85 87 85 84,64 Valid 85 85 82 80 85 84 86 85 82 85 82 83,73 Valid 644|

Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education), 11 (3), **p** .639-653, (**2023**) Based on **the** validation **results** 7

by experts in Table 4 above, the average product validation scores of the three experts are successively 83.91; 84,64; and 83.73 so that the product developed is classified as valid and suitable for use. Product Revisions Although according to experts, the product is PjBL wiith STEAM approach meets the validity criteria and is feasible to continue with field trials, but there are several components that need to be revised according to experts, including: 1) Aspects of indicator formulation, namely the need to use operational verbs C4, C5, and C6 that measure high-level thinking ability, 2) Aspects of learning activities, it is recommended to use various variations in learning so that learning is more interesting, 3) Aspects of language use, it is recommended to use language that is easy for students to under- stand. Product Practicality The practicality of the product developed is tested based on practicality scores by experts and the implementation of learning carried out by teachers in teaching ecosystem materials using previously established practicality criteria. Based on the data obtained from the observation sheets that have been collected both observation sheets by experts and teacher responses, presented as Table 5. Table 5. Results of the Practicality Assessment of the Developed Model Validators Score Category Material Expert 82,25 Practical Technologist 84,14 Practical Linguist 80,54 Practical Average 82,31 Practical Based on the validation results of experts by both the first, second and third ex- perts and the average results from validation show that PjBL with STEAM approach model developed is relatively practical. The practicality of the product based on the implementa- tion of learning carried out by biology teachers using the developed product is presented in Table 6. Table 6. Results of the Practicality Assessment of the Products Developed Aspects Meeting First Second Third Learning Objectives 84 84 85 Motivating Students 85 85 85 Giving real problems 82 84 82 Material Mastery 83 80 82 Guiding students 80 82 82 Application of learning syntax 79 80 80 Classroom Management 82 80 85 Evaluation 80 84 85 Conclusion 82 84 85 Average 81,89 82,56 83,44 Category Practical Practical Practical Nuraini, et al.:

Development of Project Based Learning With STEAM Approach Model .....|645 Referring to **the** 4

scores shown in Table 6 above, it shows that, the application of PjBL with STEAM approach model in improving science literacy ability for 3 meetings shows that the learning model used in learning is included in the practical category both at meetings 1, 2, and 3. However, based on the results of observations at each meeting, there are several things that must be improved in the implementation of learning. At the first meeting, the results of the observations showed that the teacher needed to make improvements 1) the teacher needed to provide real problems according to the material being taught, 2) re-examine the sequence of learning syntax so that the implementation of learning was more systematic and follow the syntax that had been formulated in the learning design, 3) in drawing conclusions, it was suggested that the teacher first ask the students to draw conclusions and the teacher directed not the teacher who immediately conclusion. In the second meeting, the results of the observations showed that mastery of learning syntax is still not fully mastered by teachers, this is because the application of PjBL with STEAM approach model in improving science literacy ability tends to be new to teachers and it is recommended that the learning syntax be better understood. At the third meeting, the real problems chosen by the teacher in the initial activity need to be adapted to the material being taught and more challenging which requires various strategies in solving. In addition, teachers need mastery of maateri both essential and advanced materials because this will affect the management of the class carried out by the teacher. In drawing conclusions, the teacher also needs to ask the students to draw conclusions and the teacher provides reinforcement. Based on the data presented above, it can be said that students' science literacy and understanding of students' concepts can be improved by innovating in learning using PjBL with a STEM approach during the learning process (Anggereini, 2023).

Hal ini juga **sejalan dengan penelitian yang dilakukan oleh** Fadlina (**2021) yang** menyatkan **bahwa** 27

the innovation of the STEM PjBL model in improving **students' scientific literacy** 38

students. Product Effectiveness The effectiveness of the product developed is PjBL with STEAM approach model as

can be seen from the pretest and posttest scores on **the** ecosystem material. **The** 30

scores of the pretest results and postest of the students science literacy are shown as in Figure 1. Score of Student Science Literacy Ability 90 80 70 60 50 40 30 85 82 80 25 24 26 Indicators of PjBL with STEAM Figure 1. The scores of the pretest and postest of the students science literacy 646|

Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education), 11 (3), **p** .639-653, (**2023) The test** 7

was given to 35 students in class X of Senior High School with average score of the pretest and postest was 26,67 and 81,83 of ecosystem material. Of the 35 class X high school students who were given the test on the ecosystem material, there were 32 students or 91.43% who got a test score of ≥ 75 and only 3 students who did not complete the test score < 75. It can be concluded that the percentage of student completion in learning, which is 91.43%, meets the criteria for the implementation of the product developed, namely the classical score of students after getting learning PjBL with STEAM approach model of least 85%. Thus the product developed is effective to use.

The results of this study are in line with those **conducted** 18

by Putri & Usmeldi (2022) that learning with a STEM approach can increase scientific literacy, because it contains steps that accommodate literacy skills at the time of learning. Similarly, research conducted by Astuti (2023) shows that the STEAM approach can increase students' science literacy and creativity. This is in line with Anekawati (2021) states

that science skill process influenced cognitive learning outcome in the learning process using the PjBL model integrated with STEAM, and there was a different influence between the group of students with right and left brain dominance 10

. Meanwhile, Shamdas (2023) states that applying STEAM had a significant effect on high school students' communication skills compared to direct STEM-based learning. Testing whether the learning model developed has the potential to improve student biology learning outcomes is determined based on the N-Gain value, namely the difference in postes and pretest scores on ecosystem materials after going through trials of applications PjBL with STEAM approach model. Based on the calculation results obtained N-Gain of 0.76 is included in the high category.

Based on the foregoing, **it can be** said **that the application of PjBL** with STEAM approach **model** 26

has high potential in improving science literacy ability of the biology of the ecosystem material of high school students.

This is in line with the research Fatimah (2018) **which** explains **that** PjBL gives **students** 34

greater opportunities to think and explore their ability to complete tasks and find the right concepts and is significantly able to improve students' science literacy skills.

STEM-based project learning was able **to increase** the average critical **and creative** thinking **skills of** 37

students on all indicators that varied from low to moderate categories (Sumarni, 2020). Learning with PjBL begins with the presentation of important issues and students are asked to play an active role in conveying their ideas and ideas about the material related to it. At the project design stage, students actively discuss conducting experiments, then students present the results of their projects. The series of activities carried out in biology learning with integrated PjBL science literacy is believed to be able to create student curiosity and improve students' science literacy skills. Learning with integrated PjBL science literacy is necessary to be able to provide answers to essential questions, and provide deductive and inductive conclusions on specific problems (Insyasiska, 2015). Research conducted by (Çelik, 2018) states that teachers need to support students to find and discuss solutions by allowing sufficient time. Meanwhile, Ulger (2018) states that in learning teachers can develop students' ideas and The learning of PjBL with STEAM approach model

also has a high **potential effect in improving science literacy** ability as **indicated by an N-Gain score of 0** 13

.76 in solving the problems encountered in various ways that are found. In this study, the analysis of ecosystem problems was chosen as the main problem to be solved by students. Projects designed by students are solutions to the problems faced, namely ecosystem problems. Students are divided into four groups with each group given the freedom to determine the materials Nuraini, et al.: Development of Project Based Learning With STEAM Approach Model.....|647 and methods used to conduct an analysis of the ecosystem according to their creativity. PjBL is believed to be able to create curiosity and improve students' science literacy (Nuraini & Waluyo, 2021).

The results of this study are in line with the **research conducted** 18

by Nita (2021) which states that the application of PjBL can improve student learning outcomes and science literacy. Through PjBL with the integration of science literacy, students not only identify problems and find solutions to the problems faced, but students can also use various knowledge and abilities to solve problems (Yamin, 2020). PjBL with the integration of science has also facilitated students to develop themselves both academically and practically to find solutions in everyday life (Husamah, 2015). Meanwhile, Sasson, & Malkinson (2018) in his research stated that PjBL is included in innovative learning that can develop students' science literacy skills. By applying integrated PjBL science literacy in learning, students will be facilitated in developing their science literacy skills in dealing with contextual problems (Chen & Yang, 2019). By implementing integrated PjBL science literacy,

students are given the freedom to be more active **and express their** ideas through **the project** 32

projects they create (Ririn, 2021). By applying this integrated PjBL literacyscience, learning is not only delivered theoretically but also through direct practice in making works or products in learning (Rohana, 2017) states that learning with PjBL can improve students' literacy skills. Meanwhile, (Gunawan, 2017) states that learning to use projects can increase students' creativity and literacy. Similarly, Afriana (2018) showed that learning with PjBL can improve students' scientific literacy skills. Integrated PjBL with STEAM approach encourages students to be active and skilled in learning activities and they understand the knowledge that must be possessed through project design and its implementation. Through integrated PjBL with STEAM approach, students can build knowledge through real experiences and experiment with group members and between groups, so that students' science literacy can improve. Through PjBL with STEAM approach, student learning outcomes are better than conventional learning models (Siwa, 2013). PjBL with STEAM approach is useful in designing effective learning so that it has the potential to meet its demands. Integrated science literacy PjBL assists students in 1) strengthening meaningful knowledge and skills built through essential tasks, 2) expanding knowledge through investigation, with results or answers not determined by a particular perspective, and 3) building knowledge through real experiences that take place in a collaborative work atmosphere. This is in line with the research (Wijanarko, 2017) that

the PjBL model empowers **students' science** literacy **through scientific** work **to solve a problem and produce products so that** the **learning outcomes are maximized** . Through hands- **on** 16

experience allows students to practice using their senses, collect evidence and then follow up by asking questions or formulating hypotheses based on existing ideas so that it has the potential to improve students' science literacy ability. In the PjBL with STEAM approach, teachers need to provide guidance to each group so that each student uses critical thinking skills, using scientific principles in solving problems. Research conducted by Wolthuis (2020) states that in learning teachers must be able to manage classes well, facilitate students in learning and re-conclude the material taught. PjBL with STEAM approach, allowing students to be given the opportunity to discuss in groups to develop science and science literacy skills. Learning with PjBL has a close relationship with student science literacy, because by using the PjBL learning model students can improve their thinking skills so that students' science literacy can develop (Fitriyani, 2018). PjBL with STEAM approach, encouraging students to reflect on what they have done so that they are aware of its weaknesses and advantages (Murniyati, 2018). This results

in improving students' science literacy **skills. In** line with 648| **Jurnal Pendidikan** Sains **Indonesia (Indonesian Journal of Science Education**), 11(**3** 12

), p.639-653, (2023) the research conducted (Hardjo, 2018) that science literacy can equip students with the correct concepts of science and hopefully they can apply them to real life. Conclusion

The results of the research that has been carried out can be concluded that The PjBL **with the** 12

STEAM approach model can increase students' science lieration ability as shown by

the N-Gain value of 0.76 with a **high category** 1

. The effectiveness test of PjBL with STEAM approach ecosystem material showed that the score postest of science literacy ability with indicators of the ability to explain the facts, presenting hyphotheses and answering questions with a presentation of 91.43% from 35 students who scored above 75. Acknowledgement My

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