Simple Laser Creating Project: Perception of Motivation to Study Concepts Toward Knowledge and the Ability of Physics Education Teachers Candidates

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Abstract. This study aims to reveal the perception of motivation to study concepts and knowledge and the ability of college students who are candidates for Indonesian Physics Education teacher's bachelor's degrees in their readiness to learn laser technology with a simple laser project during the COVID-19 pandemic. By applying a combination of thematic analysis and qualitative content analysis data were obtained using interviews, questionnaires perceptions, and initial ability diagnostic tests on 264 teacher candidates on the islands of Java, Sumatra, and Kalimantan. The result revealed that teacher candidate perception of knowledge and the ability of laser technology is as low, however, the level of perception of motivation to study laser technology with experiments to create lasers belong high. The diagnosis test revealed the initial ability of teacher candidates to analyze the occurrence of lasers with atomic theory belonging low. Evidence shows there is a perception motivation gap inequality in studying laser technology towards knowledge and the ability to analyze the occurrence of lasers with atomic theory, this high perception of motivation to study is caused by college students who are very interested and challenged to learn the concept by creating a simple laser that has not yet never did they. The claim of this study we suggest including laser technology in the main topic of learning for future teachers of Physics Education through the project of creating simple lasers by further strengthening the concept of the process of occurrence of lasers with a review of atomic theory.

Keywords: Laser project, Technology, Perception of motivation, Concepts and knowledge, ability, Understanding, Atomic theory

1 Introduction

Laser is a fundamental technology in the 21st century that is important in modern human life and is used in various fields such as industry, medicine, electronics, communication, astronomy, photography, and so on. Laser is an appropriate physics material for project learning models because it relates to technology and is authentic and relevant

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content in the real world and relates to interdisciplinary science [1]–[4]. There are still a few implementations of creating lasers in learning at the college level. In contrast, several universities in the United States, China, and Taiwan teaching laser and optical materials use project learning to improve design skills, learning management, and confidence, as well as the professionalism of future progress of learners [5]–[7].

There is a very close relationship between the integration of project knowledge and skills, project skills are related to the ability of learners to integrate many ideas and provide significant experiences for learners [8]–[10]. Project learning gives a link between cognition, skills, and self-confidence. and project learning that combines face-to-face and online with technological facilities can effectively improve learners learning abilities independently, practically, applicable, and innovatively [5], [11]. Project learning involves learners with authentic real-world problems at the start of the project because facing real-world challenges is not only solved using information or skills from one subject but also with an interdisciplinary approach. [12], [13]. Interdisciplinary projects provide opportunities for learners to practice skills outside the classroom that add a new dimension and authenticity to learning, as learners not only play a role in complex processes but must also learn how to share control of that process with others [14]. The project-based learning approach through experiential learning exercises on the material and a more complete range of competencies are carried out by learners, making a large increase in understanding of the material accompanied by an increase in self-confidence [15].

One way to incorporate practical skills into higher education programs is the use of project learning, as learners will tackle new challenges with the competencies they have learned in previous projects, then continually apply those competencies to strengthen them [16]. Selecting a project that is globally relevant to the problem requires learners to use the scientific method to solve the problem, and project learning is an excellent strategy for educators to teach with a systems approach [17].

Project content can be used to increase learners learning motivation and help students to be involved in learning activities [18]. Technology can support project learning activities when the interaction of learners and educators to communicate and share information, not only their assessment but also their knowledge and skills are significantly higher [19]. A project must increase learners' motivation to learn and produce quality work, and choosing a project with a globally relevant problem will require learners to use the scientific method in solving problems [2]–[4], [17]. Lasers are a product of science and technology, therefore it is very important to learn the principles and applications of lasers at an advanced level to be able to improve learners' abilities in motivation, creativity, and problem-solving in making simple lasers because learning the concept of lasers in real life is challenging for learners in the early years and even for final year learners. How many factors can support motivation, that is: challenge, curiosity, control, fantasy, competition, cooperation, and recognition, lack of motivation can cause big obstacles that can prevent success [20].

College of science education such as Physics Education has a role in producing science teachers at the elementary and upper secondary levels whose competence is in teaching theoretical science and teaching research, but less oriented towards applied

technology with interdisciplinary knowledge compared to applied universities, and universities Science education is usually more closely collaborating with schools and the educational environment than with employers for graduates.

In teaching in higher education, learning is limited to only theory and just practice proof, still has not developed teaching in interdisciplinary applied engineering because it is limited to the curriculum, a form of interdisciplinary project teaching as a way to support the development of 21st-century skills. Multidisciplinary learning project with multiple objectives developing problem-solving and communication skills. In professional skills, the core learning objective is to increase learners' motivation. The teaching of applied engineering curriculum involves several professional groups as teachers, in this case, there are science teachers (mathematics and physics), language teachers, and certain information technology professionals. This encourages the retention of each other's professional culture and learning planning from the internal logic of each discipline. These professional groups barely mingle, because the curriculum is organized in its learning, and the main subjects are separated from each other. Along with curriculum changes that develop 21st-century skills, organizational reforms are being made to integrate and bring disciplines closer together and create new ways to collaborate [14], [15], [29]–[33].

And this research focuses on revealing what is important about the perception and understanding of Physics Education teacher candidates in their readiness to learn laser technology with a simple laser project during the COVID-19 pandemic. Perception is the act of compiling, recognizing, and interpreting the understanding of information about the environment formed by learning, memory, hope, and attention and selectively interpreting perceptions that are seen based on interests, backgrounds, experiences, and attitudes [21]–[23]. In this case Perception of the project of making simple lasers at the university level by third-year teacher candidates at 8 Indonesian Universities on the islands of Java, Sumatra, and Kalimantan. By collecting and analyzing data from the entire population of prospective teacher candidates, it can be seen what appears in classroom learning, an extensive reflection of data collected and analyzed from interview questionnaires and diagnostic tests of the third-year teacher candidates after they study basic and advanced physics in modern physics. This research will provide broad insight into what Physics Education teachers candidates who are deeply involved with project learning will do, and what is most important is that their desire goes beyond what the studied literature can provide because project teaching is learning that optimizes learners' skills and knowledge when properly just right [14], [24]–[28]. With the disclosure of the real situation about the perception of motivation to learn concepts and knowledge as well as the ability of teacher candidates to learn laser technology with a simple laser project so this information that is can be used to develop effective learning strategies for improving learners learning abilities to integrate theoretical knowledge into applied technology by interdisciplinary knowledge.

1.1 Research Questions

To reveal what is important from perception and ability to readiness to learn laser technology by a teacher's third-year candidate by creating a simple laser project using project learning in college, then researchers need to find answers to research questions by knowing:

1 How are the motivational perception in understanding and knowledge of college students in studying lasers by creating simple lasers?
2 What is the initial ability of college students in their readiness to study laser technology, by looking at their abilities: analyzing atomic models, solving problems related to filling electron configurations, explaining energy band theory, and analyzing the occurrence of lasers with atomic theory?

2 Method

The research used qualitative data collected in the form of ideas, questions, and difficulties obtained from questionnaires, interviews, and quantitative data were collected in the form of diagnostic tests on third-year Physics Education teacher candidates. To find and analyze common themes related to the candidate's perception and understanding in the learning of a simple laser manufacturing project, by applying a combination of thematic analysis [34] and qualitative content analysis including data quantification [35]. Thematic analysis is useful for identifying common themes within and across data sets. With this quantification aims for a more systematic examination of qualitative data to reveal patterns in the data for descriptive interpretation. The qualitative data set is segmented into statements, each of which is considered to represent an emerging idea. Data collection from questionnaires, interviews, and diagnostic tests were combined for analysis to answer the research questions. In the next stage, themes are identified at the interpretive level because the goal is to understand the underlying ideas, assumptions, and reasons. Furthermore, each statement is also categorized according to whether the statement represents a positive point of view such as in terms of benefits, successes, opportunities, and so on. or negative viewpoints such as in terms of challenges, failures, obstacles, and others to problems in making simple laser projects during the COVID-19 pandemic.

3 Results and Discussion

The results of 12 questionnaire questions perception and 14 questions of test diagnostic of initial ability in the combination of multiple choice and essays obtained online with e-learning whose implementation involved 264 third-year teacher candidate students at 8 Indonesian Universities on the islands of Java, Sumatra, and Kalimantan, with 196 people (74.24%) being women and 68 people (25.75%) is male.

Table 1. Questionnaire questions and responses from teacher candidates to answer research questions.

No	Question	Response/Answer			
1	As a physics student, are you interested in proving physics concepts by experiment?	Very interested	Interested	Not interested	
		42,6%	55,7%	1,7%	
2	Have you ever done a practicum in studying physics?	Yes always	Yes Often	Yes I have	Never
		16,9%	49,8%	32,5%	0,8%
3	Are you interested in making tools in physics to help you understand physics concepts?	Very interested	Interested	Not interested	
		25,7%	70%	4,3%	
4	Do you know lasers?	Yes Very Knowing	Yes It's Enough to Know	Yes Know only the name of the term	Not at all
		15,2%	32,1%	48,5%	4,2%
5	Do you know laser technology related to physics concepts?	Very Knowing	Knowing	Little Knowing	Do not know
		5,9%	38,8%	45,6%	9,7%
6	Do you understand the concept of laser theory in physics?	Very Understanding	Understand	Little Understanding	Not Understanding
		1,3%	14,8%	58,6%	25,3%
7	Are you interested in learning the concept of lasers by conducting experiments to make simple lasers, so that they can help you better master the concept?	Very interested	Interested	Not interested	
		18,1%	74,7%	7,2%	
8	Do you agree to experiment to create a simple laser to help understand the laser concept in learning?	Strongly agree	Agree	Disagree	
		16,9%	77,2%	6,1%	

No	Question	Response/Answer		
9	Are you motivated to understand the concept of a laser by creating a simple laser?	Very Motivated	Motivated	Not Motivated
		14,8%	78,4%	6,8%
10	Are you motivated to understand the concept of a laser by creating a simple laser?	Very Knowing	Knowing	Don't know
		5,9%	21,1%	73%
11	Can you create a simple laser? (Assembling yourself, not buying factory products)?	Yes, can	Maybe Can	Can not
		8%	65,8%	26,2%
12	Are you challenged to create a simple laser from materials that are around you, if there is a mentor (lecturer/teacher/expert technician) who teaches you?	Very Challenging	Challenged	Unchallenged
		15,6%	71,3%	13,1%

The questionnaire questions in table 1 aim to reveal the factors that can affect the perceptions of learner's motivation for Physics Education teacher candidates in their readiness to learn laser technology with a simple laser project, such as perceptions of challenges, curiosity, fantasy, competition, and recognition, experienced by prospective teachers when carrying out the act of compiling, recognizing, and interpreting. understanding of information about the environment that has been shaped by learning, in the form of memories, expectations, and attention that are seen based on one's interests, background, experience, and attitude when placing oneself when going to experience it.

Table 2. Basic Competencies with the material to be tested as a diagnostic test

No	Basic competencies	Theory	Question number
1	Analyzed the atomic model	Atomic Theory	1,2,3,4,5,6
2	Solved problems related to electron configuration	Charging Electron Configuration	7,8
3	Explained the energy band theory	Energy Band Theory	9,10,11
4	Analyzed the occurrence of lasers with atomic theory	Laser	12,13,14

Table 3. Results of preliminary ability diagnostic test

No	Origin of Sample Subject	Number of Samples (N)	Diagnosis Results Based on Basic Competence Mastery Ability				Diagnosis Based on Overall Average Results
			Analyzed the atomic model	Solved problems related to electron configuration	Explained the energy band theory	Analyzed the occurrence of lasers with atomic theory	
1	Central Kalimantan	55	67,94	63,57	58,04	17,84	55,71
2	West Java	58	60,85	65,3	50,14	30,46	52,68
3	Yogyakarta	22	50,76	48,3	31,44	24,24	40,58
4	Sumatra (Lampung)	39	54,81	50,96	43,8	17,09	43,82
5	East Java (Malang)	75	53,40	54,38	53,60	47,96	47,41
6	South Kalimantan	15	61,39	49,17	46,11	36,67	51,07
Overall Average		264	58,19	55,28	47,19	29,04	48,55

Table 4. Sample results of researchers' interviews on student's difficulty to give an analysis description of answers related to the analysis knowledgeability of the laser

Research interview questions	College student answers								
	Fajar	Pajri	Panji	Busairy	Maulida	Indana	Khairunisa	Euis	Tia
"How are general responses to questions referring to laser applications theory explained using the atomic theory from no 1 to 9 are the basic theories to explain laser?"	"From some of the questions, there are some materials that have not been completely understood even though already learned and their understanding is still low, maybe a more detailed answer elucidation is needed or there is a need	"Yes sir, agree with the reasons other friends"			"Yes sir, agree with the reasons other friends"	"Yes sir, agree with the reasons other friends"			"Yes sir, agree with the reasons other friends"

Research interview questions	College student answers								
	Fajar	Pajri	Panji	Busairy	Maulida	Indana	Khairunisa	Euis	Tia
	for more detailed references in the explanation Like problems 12 and 14"								
"And for figure no. 12, process at the atom level of the theory of laser occurring, do the students have never received mater, so there is still confusion in explaining the laser process happened?"	"Yes and for the laser process at the atom level I have never received the matter and explanation"				"Yes sir, agree with the reasons other friends"			"Yes sir, agree with the reasons other friends"	
"Do you get the material in basic from high school levels to learning in modern physics like atom theory, atoms can experience excitation and absorption and understand it?"	"yes sir, I ever get the material at the high school levels and modern physics lecture and still remember the concept"	"Yes sir, I have ever gotten the material at the high school levels and modern physics lecture"			"Yes sir, agree with the reasons other friends"		"Yes sir, agree with the reasons other friends"		"Yes sir, agree with the reasons other friends"
"Do you have difficulty explaining questions no. 12 to 14, which caused you to have difficulty in analyzing and explaining the event of the laser at the atom level?"	"Yes sir, I agree"		"Yes sir, I agree"	"Yes sir, I agree And maybe the lack of information can make be confusing to analyze it"					
"When the atomic concept is	"Same as any other friend who				"Maybe Due To	"Yes sir,		"Maybe, the same	

Research interview questions	College student answers								
	Fajar	Pajri	Panji	Busairy	Maulida	Indana	Khairunisa	Euis	Tia
implemented on the laser by explaining the event of the laser, you difficult to explain it may need additional references and explanations from the lecturer or teacher?"	reads fewer references, and I need more references, also the theory and practice implementation is not compatible, and the implementation is not suitable for understanding the concept"				Less Remembering And Less Information Also References"	agree with the reasons other friends"	"Yes sir, agree with reasons other friends For lack of understanding and mastering the basic concepts and their implementation"	as experienced by other friends, i.e. Less understanding of the concept and its implementation do not know"	"There is nothing wrong with the problems because I am less knowledgeable about them and may not understand more details about the basic concept"

Research interview questions	College student answers								
	Fadia	Aufa	Riki	Sri	Pian	Syaidah	Daynta	Arif	Lisma
"What are students' difficulties when answering the questions from no 1 to 14"	"All question I can understand only the question part for energy bands theory and laser from no 9 to 14 is less reading reference books and other sources, and for energy band material have already been getting in the lecture but the understanding is less deep because of frequently forget, for materials	"I have difficulty with energy-matter and laser-matter because the online learning has been difficult to understand it's also less suitable for me, and the material about atoms has never been discussed again"	"For basic concepts can still understand but for concepts from no 12 to 14 there is still confused about the quantum problem and the essence"	"For basic understanding about the atom you can still understand, but for the laser material I don't understand because it has not been reached, and no 12 is not understanding in the pictures"	"For all problems the same as the like other friends, less understanding for the concept of energy bands and its	"For atom concept, the material still remember, but for laser-matter, it is really difficult because I don't	"The concepts about the atom that I learned don't deep, and for the energy band already ever studied, for no 9 to 14	"In my opinion no. 1 to 8, the materials have been learned, But for no. 4 about the concept of the atom, I have not learned	"For no 1 to 7 already learned in senior high school if you can't answer because you have forgotten, but for no 8 to 14 not yet

Research interview questions	College student answers								
	Fadia	Aufa	Riki	Sri	Pian	Syai-dah	Daynta	Arif	Lisma
	about atom already understand because you have been in senior high school and understand more after re-reading"				laser applications, but for about the atom concept I can understand it "	understand, also no 12 to 14 cannot be answered	never learned	the depth And for energy band theory, we don't get the materials	understand because in lecture not learned
"Has the concept of lasers ever been taught in lectures?"			"The concept of the laser has not been taught"	"The concept of the laser has not been taught"	"Laser material is in quantum physics "				
"Ever in lecture, there is a project to make a laser"	"There is not yet a project to make a laser"		"There is not yet a laser project, but the equipment is in the lab"						

From the results of the questionnaire table 1 for the perceptions of 264 student teacher candidates about laser learning with the simple laser-making experiments, respondents are in the third year showing the results are still a low percentage of learners in recognizing laser technology related to physics which is less than 45%, However, the level of motivation to understand and master laser technology by conducting experiments is generally very high, with more than 80% for the perception of learning the concept of lasers by being challenged to make simple lasers.

Table 3 results data for the diagnosis of 264 teacher candidates using a written diagnostic test technique in the form of an analytical rubric instrument to measure learners' knowledgeability [36]. The results of teacher candidate knowledgeability of the process of laser occurrence by analyzing atomic models, solving problems related to electron configuration, explaining energy band theory, and analyzing laser occurrence with atomic theory from preliminary research. The results of the overall average score with criteria classified as low (48.55), in detail the diagnosis based on mastery skills: analyzing models with criteria classified as sufficient (58.19), solving problems related to electron configuration with criteria classified as sufficient (55, 28), explaining the energy band theory with criteria classified as low (47.19), analyzing the occurrence of lasers with atomic theory with criteria classified as very low (29.04).

Table 4 shows the results that were captured in interviews by researchers with teacher candidates showing the difficulties experienced in understanding the concept of lasers and atoms also their implementation. Most of the teacher candidates have

never received an explanation of the process of laser occurrence at the atomic level and the concepts about the atomic theory that have been studied are not deep, also lack reading and understanding references so difficult to analyze the concept of laser implementation with atomic theory. There is online learning information about atomic and laser theory which is less effective for some students in college so it affects understanding, and there is no yet laser project in the learning process.

The results of perceptions and diagnostics, as well as interviews with teacher candidates on understanding laser technology, found that they were only familiar with the term and the laser as an instrument that was usually used for presentation pointers or toys, and have not yet analyzed the laser process in depth, this can be seen from the results of the average score which is still very lacking. And to introduce and understand laser concepts effectively through project-based learning, as well as making a form of learning the implementation of atomic concepts with how the laser technology process works. Of this, teacher candidates are expected to gain a deep understanding not only theoretically but also of how to design simple laser experiments, understand the working principle of the equipment made, the relationship between theoretical concepts, and the results of observations of their application and produce a tangible product. This way of learning begins with motivating questions and results in in-depth learning where learners complete an investigation to answer questions. Because the most meaningful questions focus on real-world situations that are usually interdisciplinary fields of knowledge because education in the 21st century is heavily influenced by technology and globalization [18], [36]–[43].

The demands in education in this century are the mastery of technology, such as laser equipment which is currently the result of science and technology that continues to be developed and perfected, also supported by the results of questionnaires and diagnoses about understanding lasers and very high motivation in studying them, From this, learners should be taught at the university level, especially physics students, to be taught problem-solving skills in terms of mastering laser technology because in the current era of globalization they are trained to be able to create a useful product with project-based learning.

4 Conclusion

Evidence shows there is a motivational gap inequality in understanding laser technology towards knowledge and the ability to analyze the occurrence of lasers with atomic theory, this high perception of motivation is caused by learners who are very interested and challenged to learn the concept of the laser by making a simple laser that has not yet never did they. The claim of this study, we suggest including laser technology in the main topic of learning for future teachers of Physics Education through the project of creating simple lasers by further strengthening the concept of the process of occurrence of lasers with a review of atomic theory. From the results of the perception of high motivation to study lasers, it was concluded that lasers are suitable physics materials for project learning because they are related to technology and are authentic and relevant content in the real world, and can increase learning motivation and related to

interdisciplinary science, to improve the integration of knowledge, significant applicable and innovative ideas, and experiences for learners.

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