

## **Advantages of Various Technologies in the Application of ICARE to Train Undergraduated Students' HOTS Capability**

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**Abstract**—Learning technology consists of a system of rules, tools, and activities that are all designed to bring students to achieve learning goals in a systematic, effective, and economical manner. Higher Order Thinking Skills (HOTS) is a basic achievement in scientific learning, especially Physics. The achievement of HOTS in learning is an indicator of the success of learning Physics at Universitas Negeri Medan. This type of research is quasi-experimental using a two-group pretest-posttest design. Place of research in the Physics Education Study Program, Universitas Negeri Medan-Indonesia for the academic year 2021/2022. Data analysis used Anava Two Ways with Posthoc test and Linear Correlation Analysis. Presentation is an activity that is rarely carried out, especially in physics learning, which can be done experimentally. This presentation of results can take many forms besides using technology in a live presentation. This is what causes technology to be used less in presenting learning outcomes. The optimization of this increase can be seen clearly in the presentation shown by the low-skilled sample group in both types of samples. This needs to be done in practice to be able to optimize the use of technology and skills possessed by Undergraduate students. Structured exercises through stages that can direct student activities such as in ICARE based on TPACK.

**Keywords**—Learning, Higher Order Thinking Skills (HOTS), ICARE, TPACK

### **1 Introduction**

In the field of education, the Internet plays an important role, especially during the Covid-19 pandemic. All must depend on the help of the Internet so that education can continue. Learning is done online using learning technology that is currently emerging and still developing. Advances in the field of education today where users are increasing and need it (Bower, 2019; Ellaway, 2018; Lally et al., 2018; Mayer, 2020; Nicolaou et al., 2019). The meaning of learning technology is an application or media that has been designed in a modern way and used as theory and practice in learning, as a learning resource. Currently, the technology that is widely used in education is information technology. The existence of information used for learning media can have a positive impact on students, namely, they can more easily find the information needed during the learning process.

The media that can be used is to provide computers and the Internet in every school or university. Some of the learning technologies commonly used to help the teaching and learning process run are as follows: e-Learning, Video-Assisted Learning, Blockchain Technology, Big Data, Artificial Intelligence, Learning Analytics, Augmented Reality, and Virtual Reality, as well as the utilization of Social Media in Learning (Said et al., 2018; Sumarmi et al., 2021; Zgheib & Dabbagh, 2020). Learning technology is not limited to high technology but anything that enhances learning in the classroom in the use of blended face-to-face, or online learning. Learning technology consists of a system of rules, tools, and activities that are all designed

to bring students to achieve certain learning goals in a systematic, effective, and economical manner. Such standard technology must, of course, derive from explicit and tested scientific theory (Gordillo-Tenorio et al., 2023; Hou & Xue, 2023; Kiketa et al., 2022; W. Wang, 2022; Y. Wang, 2022). Although not an essential component of learning technology, technical devices are often used to minimize negative consequences. The negative result of fluctuations in noticing errors or mistakes, either by students or teachers (Croce et al., 2018; Martín et al., 2021; Ou et al., 2021).

In particular, the goal of instructional technology is to offer various possibilities for the technical design of learning systems and learning processes. Everything must be controlled, flexible, adaptive, and intelligently guided. The prerequisites for this system are a general learning theory and a domain-specific model for acquiring knowledge which enables the following: Analysis of learning objectives in terms of competent performance; Description of the student's initial state; Determination of methods that effectively lead to the acquisition of knowledge; and Assessment of the effects of teaching methods. The use of appropriate educational media can help optimize the use of technology in learning so that it can facilitate achieving the expected learning objectives (Ghozali et al., 2019; Mayembe & Nsabata, 2020; Ramadannisa & Hartina, 2021). The right media can also help us a platform so it can run well. The use of technology for learning has many benefits that can be useful in achieving the expected learning objectives, such as; Adding information, increasing learning ability, facilitating access to learning, more interesting and varied material, and increasing interest in learning.

The positive impact of using technology in education as a reference for seeking knowledge, so that teachers are not the only source of knowledge for students and students do not need to be too fixated on information or knowledge conveyed by teachers, but can also access subject references directly from the internet. As for the negative impact of technology on the world of education, students. Its become unfocused and have various noises for learning due to too often looking for references on the internet so that students become independent in doing assignments and others, with advances in technology (Ghory & Ghafory, 2021; Higgins et al., 2012; Tawafak et al., 2018, 2021). It should make it easier for students to focus and concentrate on studying.

Obstacles to the use of technology in learning, especially in Indonesia, are restrictions that occur in various schools which are carried out to anticipate misuse of technological tools during learning time. This limitation makes a learning culture without using technology for students. The impact is that student's abilities and skills towards technology or technology-based tools are limited. These limitations will affect literacy skills. Literacy ability is an important element in constructing knowledge at the university level (Gómez-Pablos et al., 2020; Gündüzalp, 2021; Perdana et al., 2019; Vézina & Bélanger, 2020). In addition, the implementation of learning that utilizes technology is only limited to the use of media for teachers, administering exams, administration, video conferencing, and collecting assignments.

Students also have to change the mindset of children with secondary education to a more mature level. Not only in terms of academics but also in the way of behaving and behaving, one must be able to show intellectual characteristics. Therefore, it is necessary to make efforts to get to that level. Students are considered to be able to distinguish between good and bad actions and always develop positive behavior (Khlifi, 2022; Li et al., 2022; Shi & Fan, 2023; Su et al., 2022). Students who have good character and morals can face global challenges and solve problems personally. The following are some of the characteristics that students must have, such as Critical Thinking, Responsible, Having a Mind, Being More Mature, and wanting to develop. Qualified students are not only oriented towards academic degrees

and grade points but also need soft skills that can be useful for the community and bring about better changes. Critical, democratic, and constructive thinking is always born from the mindset of students.

Universitas Negeri Medan students have characteristics with high motivation. Learning achievements from various aspects of assessment with a fairly wide area coverage, both within provinces and between provinces. Capability Students are selected by ability tests both cognitively and with the required basic abilities. In the characteristics of Physics Students, basic skills in analyzing, experimenting, and socially become the basic benchmark. Academic special values and literacy knowledge support progress and development in learning. The cultural differences that Indonesia has become a differentiation component that forms the basis of differentiation learning. This is owned by Physics Students at Universitas Negeri Medan. Various cultures are the patterns of various special skills possessed by each region.

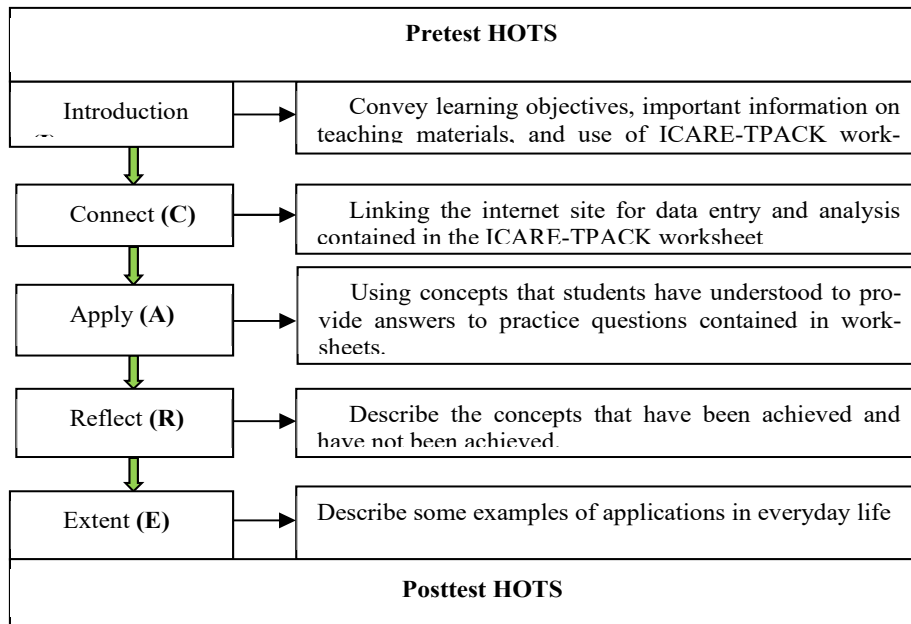
Higher Order Thinking Skills (HOTS) is a basic achievement in scientific learning, especially Physics. The achievement of HOTS in learning is an indicator of the success of learning Physics at Universitas Negeri Medan. However, in the implementation of learning, HOTS is often considered a cognitive-centered learning achievement. This is shown in the implementation which only uses a question test as an assessment instrument. This assessment becomes a mistake in the HOTS indicator assessment paradigm (Sinuraya, 2016; Sinuraya et al., 2018, 2019). Testing the question test is not only from cognitive assessment but with a single choice question. The application of a single-choice question cannot describe HOTS conditions. This makes the HOTS assessment invalid and limited to true-false answers. This misjudgment results in an error in detecting the true HOTS. HOTS is a skill that is not only assessed from the ability to answer cognitively. HOTS requires a specific assessment of cognitive processing abilities and skills in presenting answers/solutions with various considerations that are presented critically and thinking logically (Bonitalia et al., 2019; Reva, 2020; Smith et al., 2018). The HOTS assessment that occurs still needs to be developed on this indicator. The HOTS assessment needs to be improved and adjusted to the assessment indicators.

Assessment of HOTS is inseparable from the use of technology as a learning resource. The use of technology in learning is a special matter, it is necessary to have a special assessment of the skills and abilities to use technology which are part of HOTS development. HOTS development at this time needs to combine various capabilities. Assessment of HOTS which uses a technology base is a superior value in the development of learning activities. This is because technology is the main thing in life. Technology is the basis that is utilized throughout all areas of life and is a challenge that needs to be mastered as a basic ability (Ross et al., 2020; Shafiq et al., 2016; van Weert & Tatnall, 2005). The use of various technological media has become a habit for students, but the use of technology only in certain media and applications is becoming a trend. The use of applications that are centered on learning or the field of education is rarely touched and mastered. The ability to utilize and design various learning activities is a learning achievement for students at the Undergraduate level. This ability is needed to be able to present innovative learning and improve learning outcomes in the 4.0 era and beyond. It is these skills and abilities that are built for graduates of Universitas Negeri Medan, especially Physics Education as future educator candidates. Tests need to be carried out to analyze the use of technology based on HOTS as learning outcomes at the university level.

## **2 Method**

This type of research is quasi-experimental using a two-group pretest-posttest design. Place of research in the Physics Education Study Program, Universitas Negeri Medan-Indonesia for the academic year 2021/2022. Withdrawal of samples using cluster sampling technique assigned one class to be the

experimental class (using TPACK-oriented ICARE student worksheets and one class to be the control class (without using TPACK-oriented ICARE student worksheets). Each class consisted of 33 students, so the number of samples was 66 students in this study. In outline, the learning stages used the TPACK-oriented ICARE student worksheets see Figure 1. Data analysis used Anava Two Ways with Posthoc test and Linear Correlation Analysis. Assessment indicators on the use of technology consist of Literacy, Access, Presentation, and Reporting for each skill in using and Ease of using technology.



**Fig. 1.** Steps of Learning in ICARE

### 3 Result and Discussion

**Table 1.** ANOVA Two Ways Test

Dependent Variable: Learning Outcomes

Source	Type IV Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	809,935 <sup>a</sup>	3	269,978	3,501	,021
Intercept	284609,062	1	284609,062	3690,863	,000
Skills	453,443	2	226,721	2,940	,060
Class	,000	0	.	.	.
Skills * Class	,000	0	.	.	.
Error	4780,931	62	77,112		
Total	351696,186	66			
Corrected Total	5590,866	65			

a. R Squared = ,145 (Adjusted R Squared = ,103)

The results of the Anava test show that there is a difference in the learning outcomes achieved (Table 1), but there is no significant interaction effect. This cannot be represented in detail in concluding the influence of technological skills and the use of technology in learning because the value of the analysis results is unknown (Skills \* Class is. in Sig.). To find out specifically, a post hoc test was carried out with the Tukey method which is shown in Table 2.

**Table 2.** Tukey Test Analysis

Dependent Variable: Learning Outcomes

Tukey HSD

(I) Tech- nology Skills	(J) Tech- nology Skills	Mean Differ- ence (I-J)	Std. Error	Sig.	95% Confidence In- terval	
					Lower Bound	Upper Bound
Low- Experi- ment	High-Ex- periment	4,5364	3,43234	,553	-4,5253	13,5981
	Low- Control	9,8506*	3,43234	,028	,7888	18,9123
	High- Control	2,8722	4,13956	,899	-8,0566	13,8011
High -Experi- ment	Low-Ex- periment	-4,5364	3,43234	,553	-13,5981	4,5253
	Low- Control	5,3142	2,53495	,166	-1,3784	12,0067
	High- Control	-1,6642	3,43234	,962	-10,7259	7,3976
Low- Control	Low-Ex- periment	-9,8506*	3,43234	,028	-18,9123	-,7888
	High-Ex- periment	-5,3142	2,53495	,166	-12,0067	1,3784
	High- Control	-6,9783	3,43234	,187	-16,0401	2,0834
High -Control	Low-Ex- periment	-2,8722	4,13956	,899	-13,8011	8,0566
	High-Ex- periment	1,6642	3,43234	,962	-7,3976	10,7259
	Low- Control	6,9783	3,43234	,187	-2,0834	16,0401

Based on observed means.

The error term is Mean Square (Error) = 77,112.

Tukey test, it can be seen that a significant effect occurs in Low-Experiment vs. Low-Control (.028). The effect that occurs is positive for the treatment given. The use of technology in learning is more meaningful in samples with low skills. This is because the basic abilities possessed by the sample population have become the basic skills possessed by Undergraduate Students. These skills become the basis for the development of student learning in achieving more in-depth information (Croce et al., 2018; Ghozali et al., 2019; Higgins et al., 2012; Ramadannisa & Hartina, 2021; Said et al., 2018; Sinuraya, 2016; Tawafak et al., 2021). A review of the correlation test conducted on the use of technology in learning shows that there is a correlation that is not very strong (.382) on learning as seen in Table 3.

**Table 3.** Correlation Tests

Model	R	R Square	Ad- justed R Square	Std. The error in the Estimate	R Square Change	Change Statistics			Sig. F Change
						F	df1	df2	
1	,382 <sup>a</sup>	,146	,090	8,84946	,146	2,598	4	61	,045

The weak correlation that occurs is due to the skill of using technology during learning which is not the main driving factor that is specifically applied as something new. These skills are basic skills that are the subject of learning as processing skills. Undergraduate learning requires students to have basic skills which are things to be developed in learning as special skills possessed by individuals in supporting careers (Elgrably & Oliveira, 2022; Gordillo-Tenorio et al., 2023; Li et al., 2022; Prahani et al., 2022; Shi & Fan,

2023; Sun et al., 2022; W. Wang, 2022; Y. Wang, 2022). A more specific correlation analysis of the use of technology in learning can be seen in Table 4.

**Table 4.** Correlation Linear Variables Tests

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	45,310	20,898		2,168	,034
Literacy	,599	,625	,311	,957	,342
Access	-,120	1,280	-,057	-,094	,926
Presentation	-,496	,204	-,407	-2,433	,018
Report	,388	,670	,238	,579	,565

It can be seen that the use of technology correlates with learning only in Presentation. This activity shows the opposite correlation with learning. This happens because in Undergraduate learning there is a very little percentage of activities that only rely on Presentation. Presentation is an activity that is rarely carried out, especially in physics learning, which can be done experimentally. The use of technology is no longer a gathering of information and learning resources but rather a learning aid in presenting results. This presentation of results can take many forms besides using technology in a live presentation (Nadjwa Miskam et al., 2019; Nadolski et al., 2021; Prosenjak & Lučev, 2020; Yagi et al., 2022). This is what causes technology to be used less in presenting learning outcomes. Technology is used as a learning resource or source of information in exploring learning material. This is a type of adult learning. Learning is carried out independently by optimizing everything that develops according to the latest information.

The results of the study show that the use of technology is more influential in presentation. Improving presentation skills with technology is a positive effort to be able to improve learning as an experience in developing student skills. Technology is the basic ability that has been instilled in oneself since the development of the world has become advanced (Lally et al., 2018; Ou et al., 2021; Prosenjak & Lučev, 2020; Yagi et al., 2022). The impact resulting from the development of technology in the world is one of the triggers that skills in using technology are basic skills that must be possessed by modern individuals. The use of various technologies in learning cannot trigger significant changes to be used as an alternative to developing skills in learning. The use of various technologies is attempted with adjustments at the ICARE stage. This adjustment is intended to be able to support the achievement of the expected learning outcomes. The use of technology as a source, media, and learning process aid is a choice that needs to be made with special adjustments to the material presented (Gordillo-Tenorio et al., 2023; Hou & Xue, 2023; Li et al., 2022; Prahani et al., 2022). This suitability determines achievement and success in learning. The level of learning ability achieved with technology is different from learning without technology (basic teaching materials). The use of this technology aims to achieve the highest abilities possessed by students by directing their skills through various uses of technology as learning aids in presenting the results of students' thinking processes.

The arrangement of the pedagogical practice of these student worksheets uses the ICARE concept and relevant internet sites. The learning stages of student worksheets use the stages of the ICARE concept (introduction, connect, apply, reflect, extend). The introduction is the stage of conveying learning objectives, prerequisite material, time, assessment, reading materials, relevant internet sites, and so on

(Gündüzalp, 2021; Prosenjak & Lučev, 2020; Sinuraya, 2016; Smith et al., 2018; van Weert & Tatnall, 2005). Connect is the stage of introducing facts, concepts, principles, and/or processes related to the material to be studied. Apply is the stage of giving challenges and activities that allow students to apply the knowledge they get at the connect stage to solve problems presented to students. Reflect is the stage for students to reflect on what they have learned, what they have gained, and the experience gained from the connect to apply stage. Extending is the stage of allowing students to broaden the knowledge they have acquired by challenging broader problems. The ICARE learning strategy puts forward the following characteristics: active, creative, and joyful learning.

ICARE which is applied in learning physics as an approach that applies phenomena as a basic embodiment of learning physics requires support from educators' skills in preparing to learn. Meaningful learning by presenting phenomena as a basis for analysis to reach a higher level of thinking. The ability to think at a higher level is an achievement in learning that every graduate is expected to have. This ability is supported by the skills of using technology both as learning media and learning resources. The use of technology in learning that is assimilated by ICARE makes learning more varied in the process of completing and obtaining information (Ghory & Ghafory, 2021; Ghozali et al., 2019; Mayembe & Nsabata, 2020; Sinuraya, 2016; Tawafak et al., 2018, 2021). The use of technology is more focused on the ICARE stage as a medium for learning and gathering information to make it more factual and up-to-date. Presentation of information that is more interesting to be presented through various forms becomes a special assessment in the learning process. In implementing and presenting information, the role of technology is needed as a learning medium that can clarify the information conveyed. Technology can be in the form of animation, visual or audio-video media. This presentation is important in conveying information to demonstrate phenomena that are difficult for the eye to see directly. In presenting information, technology students provide support as a source of information and an attractive presentation media. This trains students' skills in presenting information that is easy to remember and becomes more interesting without reducing the meaning of the concepts conveyed in detail.

#### **4 Conclusion**

The use of technology in learning is the basis of any use of applied learning methods and models. Optimization in learning can be achieved by the optimal use of technology. Technology use skills are the basic key to achieving real and factual information processing. These skills have become the basic skills possessed by every individual with the development of technology. Increasing Higher Order Thinking is influenced specifically by skills in using technology and using technology in learning. The optimization of this increase can be seen clearly in the presentation shown by the low-skilled sample group in both types of samples. This needs to be done in practice to be able to optimize the use of technology and skills possessed by Undergraduate students. Structured exercises through stages that can direct student activities such as in ICARE based on TPACK.

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