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The Influence of SaLDI Learning Model (Stimulation, Learning Community, Discovery, Inferring) on Activity, Motivation, and Learning Outcomes of Biology of High School Students

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Abstract: The study aimed was to determine the effect of the SaLDI learning model integrated with TPACK on student activity, motivation and learning outcomes. This type of research is an experiment with a posttest-only control group design. The sampling technique is using random sampling. The sample in this study was XI 5 class as the control class and XI 6 as the experimental class, each class totalling 32 students at SMAN 14 Makassar. The instruments used were observation sheet of learning activity, questionnaire of learning motivation, learning outcome test with multiple choice type. Research data analysis includes descriptive and inferential analysis and uses non-parametric testing with mann whithney test using SPSS type 25.0. The results of descriptive analysis showed that implementing of the TPACK-integrated SaLDI learning model in the experimental class had the ability of active learning activities, very high learning motivation and good learning outcomes. The results of the infrential analysis show that the alpha significance is smaller than 0.05. So, there is a positive influence of SaLDI learning model integrated with TPACK on the activity, motivation and learning outcomes of Biology students at SMAN 14 Makassar.

Keywords: Activity; Biology; Learning outcomes; Motivation; SaLDI learning model; TPACK

Introduction

Challenges in education in this timeframe have aspects that are connected to pedagogical advances, technology and student needs in schools. One of the most fundamental challenges is the lack of understanding in using learning methods that can streamline student learning activities and outcomes (Dunlosky et al., 2013; Bijani, 2023). In line with this, after the pandemic, there are obstacles in the form of inadequate infrastructure and support systems so that student motivation in learning in the classroom is not optimal (Blackford et al., 2021; Buenfil et al., 2021). The latest educational trends emphasise that teachers optimise students in mastering soft skills and contain flexible learning elements, and foster self-confidence, motivation, activity and learning outcomes. Therefore, innovations in the learning process need to be developed.

An innovative learning model serves to build an interesting and fun environment in learning. It can encourage optimising the level of concept acquisition and student activity. Students' involvement in learning can build their knowledge more deeply (Hmelo-Silver & Barrows, 2008; Syahid et al., 2023). Such activities encourage students to construct their knowledge through collaborative activities. This can indicate them

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to exchange ideas and develop solutions to make learning more meaningful, interesting and interactive (Prayitno et al., 2022; Taggart & Wheeler, 2023; Syahid et al., 2023). The learning model can also be integrated with technology, which can provide an important role to train students to learn interactively, enthusiastically and student-centred (Hsu, 2013).

The TPACK-integrated SaLDI learning model, which stands for stimulation, learning community, discovery, and inferring, is an approach that can optimise student activity and concept mastery. This learning model can integrate various elements contribute to more effective and interactive learning. The first is the stimulation element that can spur interest and attention to participate in reviewing a learning content. Proper stimulation can increase student motivation (Shin & Bolkan, 2021; Muhammad & Juandi, 2023; Widodo et al., 2021). The learning community functions in creating a cooperative learning environment between students and exchanging ideas. Learning community also helps students to provide mutual support between peers (Brouwer et al., 2018; Muhammad & Juandi, 2023). Furthermore, discovery serves to hone students' ability to discover new knowledge through investigation and exploration of the content being learnt. Discovery-based learning can provide learning experiences and develop students' creative and critical skills (Bolkan, 2015; Mardhatillah et al., 2023). Inferring functions in training students' ability to make conclusions based on learning outcomes. The inferring ability contributes well to learning (Pudhiyidath et al., 2022; Achimova et al., 2023). This approach combines self-directed learning and active interaction by involving an e-learning platform that students and teachers can access. The learning model has advantages.

The advantage of the TPACK-integrated SaLDI learning model is that it increases student engagement and understanding through active participation in the classroom. Effective stimulation can motivate and activate students in early learning activities (Bolkan, 2015; Sprevak & Smith, 2023). Furthermore, collaborative learning optimises concept understanding and trains social-emotional skills in modern education (Lobczowski, 2020; Llorent et al., 2022). Discovery-based learning has proven that it can train creative, critical thinking skills and find solutions to problems (Saggar et al., 2016; Ulger, 2018). Furthermore, inferring can impact students in training them to make conclusions from the results of the learning process and provide experience for better decision-making (Yerimadesi et al., 2022). Overall, the SaLDI learning model integrated with TPACK can offer an approach that can improve students' learning experience and integrate stimulus, collaboration, discovery, Inferring and integrate technology in the form of e-learning, namely saldi.id. Contains learning resource components and learning activities equipped with educational games. E-learning has become a media that can train students' communication skills, collaboration, critical and creative skills, and digital skills. It can motivate students and optimise their learning activities.

Learning activities are an essential component in classroom learning activities that can contribute effectively to student learning outcomes. Learning activities can cover various aspects including physical and mental activities and provide constructivistic learning experiences. Learning activities not only affect learning outcomes but can impact metacognition, self-motivation and the ability to self-regulate the thinking process (Donker et al., 2014; Zepeda et al., 2015; Loksa et al., 2022).

Low student learning activity impacts students' learning drive and can significantly affect learning outcomes (Hussain et al., 2018; Keller et al., 2017). Good learning activities can optimise students' understanding and mastery of material in the classroom. There is a close relationship between learning activities and learning motivation, students who are more active in class tend to have higher learning outcomes than those who are less active (Chan, 2016; Nguyen, 2017). Adnan et al. (2017) stated that things that can spur student learning activities could be through learning based on constructivistic theory, namely learning personality that can encourage activities to explore learning concepts. Using innovative teaching materials that are attractively designed can increase student learning activities in the classroom (Aldi et al., 2022a; Aldi & Ismail, 2023). Optimal learning activities can achieve more effective learning objectives due to collaboration between students and teachers to students, it can create exciting learning activities (Chen et al., 2016; Vandenbroucke et al., 2018). Based on this, it is necessary to integrate innovative learning models.

Learning that uses innovative learning models, such as the TPACK-integrated SaLDI learning model, focuses on student activities in learning activities that can optimise academic achievement. Applying of active learning models such as Discovery Learning and Problem-Based Learning can optimise academic achievement and encourage students to learn (Bauer et al., 2016; Lo et al., 2022). The application of various models can have an excellent impact on improving students' understanding of the content being studied. The TPACK-integrated SaLDI learning model integrates various active learning activities such as discussion activities, problem solving, which has an excellent impact on honing student skills and student activities because they gain various learning experiences. Learning that builds a collaborative learning environment can make learning effective (Nokes et al.,

2015; Zhang & Cui, 2018; Zambrano et al., 2019). In line with that, technology can be integrated into the TPACK-integrated SaLDI learning model through saldi.id e-learning has a vital role in effectively training students' learning activities. The use of e-learning in learning has an optimal impact on activity, learning outcomes and learning motivation (Bouchrika et al., 2021; Zabukovšek et al., 2022; Khahro & Javed, 2022).

Learning motivation consists of intrinsic and extrinsic motivation. Intrinsic motivation is a desire to master concepts, while extrinsic motivation is motivation influenced by external factors, which include encouragement from a teacher, parents, and social environment (Chang et al., 2018; Liu et al., 2020). Therefore, learning motivation is a combination of external and internal factors that can process and help teachers and students learn. Learners who experience high anxiety tend to have lower motivation. Therefore, a learning strategy is needed to improve cognitive intervention and motivation (Donker et al., 2014; Biwer et al., 2020; Adi et al., 2022). Adnan & Bahri (2018) revealed that learning that provides nuances of guided scientific inquiry can optimise learning motivation in students. Forming an atmosphere conducive to the learning process can indicate an optimal on learning motivation. The role of parents and teachers is vital in optimising students' learning motivation to achieve deep understanding.

The TPACK-integrated SaLDI learning model has an excellent opportunity to increase student motivation in learning activities. Mainly through empowering students to be active in learning activities. This empowerment is vital in modern learning activities. Students are expected to be active in a variety of classroom activities. Students engage in discussion, exploration and collaboration regarding their learning content. Student activity in learning activities can increase learning motivation (Alioon & Delialioğlu, 2019; Padial-Ruz et al., 2019). The use of teaching materials can be a source of information that can optimise learning motivation (Adnan et al., 2022). The TPACK-integrated SaLDI learning model has better access to learning resources. Technology integration can provide support for learning activities in and out of school. Learning technology including e- with various innovative features, can increase student motivation (El-Seoud et al., 2014; Yahiaoui et al., 2022). The implementation of learning models can enable teachers to create an engaging and innovative learning environment that increases student motivation (Montoya et al., 2018).

Learning activities have a close relationship in influencing and contributing to learning outcomes. Learning activities include students conducting discussion activities, reading and completing assignments. Learning motivation, meanwhile, encourages enthusiasm and active involvement in learning activities. Students who have high motivation can be active in learning and improve their learning outcomes (Alioon & Delialioğlu, 2019; Guijarro-Romero et al., 2023). Students who have high motivation will tend to participate optimally in learning activities both in groups and independently. As in the classroom learning process involving peer assistance, students who have high motivation will be proactive in contributing to class discussion activities (Mennim, 2016; Ryder et al., 2017). In addition, there is a relationship between learning activities and learning outcomes. Students who show high learning motivation have high learning activities in the classroom. This can significantly affect student learning outcomes (Maduretno et al., 2016). Overall, motivation and learning activities contribute to improving learning outcomes. Teachers need to pay more attention to both aspects in designing effective learning experiences that can be achieved through innovative learning models.

The TPACK-integrated SaLDI learning model integrates various components that encourage students to contribute to the learning process actively. Systematic learning, such as students being directed in understanding concepts more deeply through providing direct experience and interaction with learning content. Research using active learning models such as Project-Based Learning can optimally improve concept understanding and train students' skills (Illahi et al., 2022). In line with this, implementing of the citizen science project learning model can train various student skills in the 21st century through exploration activities and build meaningful knowledge (Adnan et al., 2024). This is in line with the principle of learning models that encourage students to learn independently and actively in learning activities. The results of empirical research the implementation of learning models that can increase activity, motivation and learning outcomes. Applying n of the PBL learning model can improve student learning outcomes (Ramadhani, 2021). This indicates that students who are actively involved can understand concepts deeply.

The implementation of technology in the TPACK-integrated SaLDI learning model such as saldi.id e-learning can optimise student motivation and engagement. Implementing of local wisdom-based e-learning can increase student motivation (Lozano-Lozano et al., 2020; Sun-Yi & Yun-Hee, 2023). This proves that innovations in learning models can create a more meaningful and engaging environment and support students' academic achievement. In general, the TPACK-integrated SaLDI learning model can improve activity, motivation, and learning outcomes by integrating innovative, active, and creative approaches.

As well as providing technology integration to create an innovative learning environment.

Based on previous research that shows various effects of specific learning models on activity, motivation, and learning outcomes. One of the research results relevant to the TPACK-integrated SaLDI learning model is implementing the Project Based Learning (PBL) model. PBL implementation can significantly optimise learning outcomes (Guo et al., 2020; Ramadhani, 2021). In line with this, using innovative teaching materials can effectively improve student learning outcomes (Aldi et al., 2022b). This shows that students actively involved in learning activities can increase deeper understanding and higher learning outcomes compared to conventional methods. This is by the TPACK-integrated SaLDI learning model principle, which encourages student involvement in learning activities. The TGT learning model can optimise student learning motivation. The research can make students actively involved in group discussions in collaborative activities that show a significant increase in motivation and learning outcomes (Wu et al., 2013; Putri et al., 2023; Ramadanti & Fikroh, 2024). This aligns with the TPACK-integrated SaLDI learning model that emphasises offline and online collaboration. Research implementing a blended learning approach can effectively improve learning outcomes and student activity using an e-learning platform (Kiviniemi, 2014).

The TPACK-integrated SaLDI learning model integrated with e-learning has the opportunity to improve engagement and learning outcomes. Research using the Brian Based Learning or BBL learning model can show that students can deeply understand the concepts learned, improve learning activities and outcomes and provide meaningful experiences (Suarsana et al., 2017). In line with this, the ICT-based constructivistic Biology learning model can increase motivation, learning outcomes and metacognition by providing meaningful experiences (Adnan et al., 2014). This can prove that learning models that emphasise learning activities can have an impact on improving learning outcomes.

The novelty of this research is implementing the SaLDI learning model integrated with TPACK contains syntax or learning stages, which include stimulation, learning community, discovery, inferring. There are reaction principles, social systems, support systems, instructional impacts and supporting impacts. This learning model uses saldi.id e-learning, which contains various interactive features. Such as class management, teachers, students, interactive learning activities, and interesting learning resources. This research is essential because students need to be equipped with the ability to perform optimal learning activities, have interesting learning experiences and be highly motivated to improve learning outcomes. Therefore, the research contribution includes improving activity, motivation and learning outcomes and contributing to developing other innovative learning models. This study aims to reveal the effect of the SaLDI learning model integrated with TPACK on the activity, motivation, and learning outcomes of Biology students of SMAN 14 Makassar.

Method

This research is a quantitative study that is a type of Experiment research (Creswell, 2015). This research design is posttest-only control group design. The experimental class used the SaLDI learning model integrated with TPACK and the control class used the STAD-type cooperative learning model. The place of this research was SMAN 14 Makassar, conducted from August to September 2024. This study has a population consisting of 6 study groups of class XI at SMAN 14 Makassar. Then, the sample was drawn by random sampling from the population. Therefore, class XI.5 was selected as the control and class XI.6 as the experiment.

This study used data collection techniques including learning activity observation sheets aimed at measuring student learning activities, learning motivation questionnaires, multiple-choice student learning outcomes tests. It also used data analysis, including descriptive and inferential analysis. The non-parametric testing with the Mann Whitney test was assisted by SPSS type 25.0 software. The stages of research implementation can be observed through Figure 1.

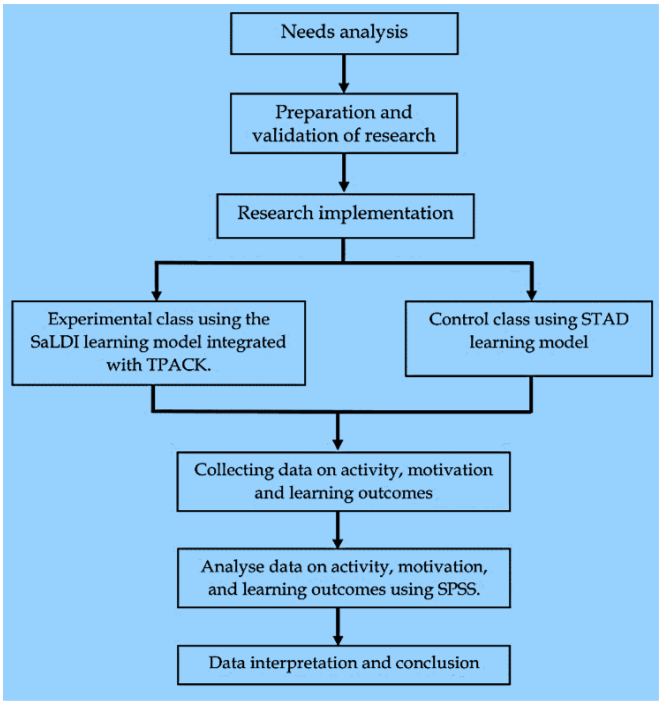

Figure 1. Flowchart of the stages of research implementation

Result and Discussion

Inferential Statistical Analysis of Students' Activity Ability, Motivation, and Learning Outcomes

Table 1. Descriptive statistics of student learning activities in experimental and control classes

Statistics	Posttest	
	Experiment Class	Control Class
Sample Quantity	32	32
Average	87.91	80.47
Highest Score	91.00	85.00
Lowest Score	86.00	70.00
Standard Deviation	1.30	3.34

Based on Table 1, it can be observed that the average learning activity score of the experimental class is more dominant than the control class. The average posttest learning activity of the experimental class was 87.91, while that of the control class was 80.47. Therefore, the difference between the two is 7.44. The highest value found in the experimental class was 91.00, while in the control class, it was 85.00. Furthermore, the standard deviation of the experimental class is 1.30, while the control class is 3.34. In line with this, the application of innovative learning models has a high average value of learning activities compared to conventional learning models (Tendrita & Sari, 2020; Wahyuni et al., 2023).

The learning activity scores were then grouped by category. Grouping is done based on student activity in the learning process. Table 2 below shows the frequency distribution and percentage of student learning activities in the experimental and control classes.

Table 2. Frequency distribution and percentage of student learning activities in experimental and control classes

Statistics	Posttest			
	Experiment Class		Control Class	
	F	%	F	%
Very Inactive X < 60	0	0	0	0
Less 61 ≤ X < 70	0	0	1	3.12
Simply 71 ≤ X < 80	0	0	11	34.38
On 81≤ X < 90	29	90.63	20	62.50
Very Active 91 ≤ X ≤ 100	3	9.37	0	0

The value of student learning activities in Biology class XI semester I obtained by students in Table 2 interprets that in the experimental class, there were 3 (9.37%) students who obtained activity scores classified as very active and 29 (90.63%) students who were classified as active. So, the total number of students who fall into the active and very active categories is 32 (100%). Whereas in the control class there were 1 (3.12%) student who was classified as less active and 11 (34.38%) students had activities classified as moderately active and 20 (62.50%) students who were active in the learning process. So, the total number of students classified as moderately active and active is (96.88%). In line with this, the implementation of innovative learning models can be dominant in obtaining very active scores compared to conventional learning model classes (Septyowaty et al., 2023).

Table 3. Descriptive statistics of learning motivation in experimental and control classes

Statistics	Posttest	
	Experiment Class	Control Class
Sample Quantity	32	32
Average	87.91	76.56
Highest Score	93.00	85.00
Lowest Score	80.00	68.00
Standard Deviation	3.94	5.87

Table 3 shows that the average student learning motivation in the experimental class is superior to the control. The average posttest score of student learning motivation in the experimental class was 87.91, while in the control was 76.56, with a difference of 11.35. The highest score in the experimental class reached 93.00, while in the control it reached 85.00. The standard deviation in the experimental class was recorded at 3.94, while in the control class it was 5.87. In line with that, the application of innovative learning models has a high average value of learning motivation compared to conventional learning models (Nur, 2018; Safitri et al., 2023).

Furthermore, student learning motivation scores are grouped based on categorisation based on the level of student learning motivation. The frequency distribution and percentage of student learning motivation in the experimental and control classes can be seen in Table 4.

The value of student learning motivation in Biology class XI semester I obtained by students in Table 4 interprets that in the experimental class, there were 30 (93.75%) students who obtained learning motivation scores classified as very high and 2 (6.25%) students classified as high. So, the total number of students who fall into the active and very active categories is 32 (100%). Whereas in the control class there were 1 (12.50%) student who was classified as moderate and 13 (40.63%) students had learning motivation classified as high and 15 (46.87%) students who had high learning motivation.

So, the total number of students whose learning motivation is classified as high and very high is (87.50%). In line with this, implementing innovative learning models can dominate to get very high scores on student learning motivation compared to conventional learning models (Akida et al., 2023; Fauziah et al., 2023).

Table 4. Frequency and percentage distribution of student learning motivation in experimental and control classes

Statistics	Posttes			
	Experiment Class		Control Classt	
	F	%	F	%
Very Low X < 50	0	0	0	0
Low 50 ≤ X < 59.99	0	0	0	0
Medium 60 ≤ X < 69.99	0	0	4	12.50
High 70 ≤ X < 79.99	2	6.25	13	40.63
Very High 80 ≤ X ≤ 100	30	93.75	15	46.87

Table 5. Descriptive statistics of student learning outcomes in experimental and control classes

Statistics	Posttest	
	Experiment Class	Control Class
Sample Quantity	32	32
Average	85.66	76.94
Highest Score	92.00	88.00
Lowest Score	80.00	70.00
Standard Deviation	4.32	5.13

Based on Table 5, it can be observed that the average score of learning outcomes in the experimental class is much higher in the control. The average posttest score for the experimental class was 85.66, while the control class was only 76.94, with a difference of 8.72. The highest score was in the experimental class of 92.00, while in the control class it was 88.00. In addition, the standard deviation for the experimental class was 4.32, while the control class had a standard deviation of 5.13. In line with that, the application of innovative learning models has a high average value of learning outcomes compared to conventional learning models (Nurmayani et al., 2018; Halimah et al., 2023).

The learning outcomes were further categorised based on student achievement during the learning process. Table 6 below shows the frequency distribution and percentage of student learning outcomes from both experimental and control classes.

The learning outcomes of Biology students in class XI semester I displayed in Table 6 show that in the experimental class, there are 8 students (25%) with sufficient learning outcomes, 18 students (56.25%) in the good category, and 6 students (18.75%) in the excellent category. Therefore, the total number of students in the good and excellent categories was 24 students (75%). Meanwhile, in the control class, there were 11 students (34.38%) in the poor category, 15 students (46.87%) in the fair category, and 6 students (18.75%) in the good category. The total number of students in the control class who were in the sufficient and good categories was 65.62%. Implementing an innovative learning model can dominantly obtain very high scores on student learning outcomes compared to conventional learning models (Sholikhah & Alyani, 2022; Rashid et al., 2024).

Table 6. Frequency distribution and percentage of students' learning outcomes ability in experimental class and control class

Statistics	Posttest			
	Experiment Class		Control Class	
	F	%	F	%
Very Low X < 63	0	0	0	0
Less 64 ≤ X < 72	0	0	11	34.38
Simply 73 ≤ X < 81	8	25.00	15	46.87
Good 82≤ X < 90	18	56.25	6	18.75
Very good 91 ≤ X ≤ 100	6	18.75	0	0

Inferential Statistical Analysis of Students' Activity Ability, Motivation, and Learning Outcomes

This study conducted a prerequisite test using a normality test to see the distribution of normal samples. The results obtained are information on the probability value of Kolmogorov-Smirnov and Shapiro-Wilk, in the experimental class and control class the alpha significance value is smaller than 0.05. Therefore, the data is not normally distributed, so using the selected inferential statistical analysis is non-parametric. Therefore, the data is not normally distributed, so using the selected inferential statistical analysis is non-parametric (Mann Whitney).

Table 7. Mean rank pretest and posttest activity, motivation, and student learning outcomes

	Group	N	Mean rank	Sum of rank
Posttest Learning Activity	Experiment	32	48.50	1552.00
	Control	32	16.50	528.00
Posttest Learning Motivation	Experiment	32	46.33	1482.50
	Control	32	18.67	597.50
Posttest Learning Outcomes	Experiment	32	44.88	1436.00
	Control	32	20.13	644.00

Table 7 and 8 show that there is a difference in learning activities between the experimental and control classes. This can be seen from the Asymp.sig. (2-tailed)

value for learning activity, which shows (0.00 < 0.005), as well as the mean rank of the experimental class, which is higher in the control class (48.50 > 16.50). Therefore, the SaLDI learning model integrated with TPACK has a positive influence on student learning activities significantly. This is in line, applying of innovative learning models can increase learning activities in students (Risdawati et al., 2017; Jumiah et al., 2022; Ismail et al., 2024). There is a difference in learning motivation between the experimental and control class, classes, as indicated by the Asymp.sig. (2-tailed) for learning motivation (0.00 < 0.005), with the mean rank of the experimental class higher in the control class (46.33 > 18.67). This shows that the TPACK-integrated SaLDI learning model also positively influences students' learning motivation significantly. This is in line, with the implementation of innovative learning models can increase learning motivation in students (Amri & Nursida 2017; Nur, 2018). When viewed from learning outcomes, there is a significant difference between the experimental and control classes, as seen from the Asymp.sig. (2-tailed) for learning outcomes (0.00 < 0.005), with the mean rank of the experimental class higher in the control class (44.88 > 20.13). Therefore, the SaLDI learning model integrated with TPACK has a positive effect on student learning outcomes significantly. This is in line, with the implementation of innovative learning models can improve learning outcomes in students (Putra, 2020; Halimah et al., 2023).

Table 8. Non-parametric test (Mann Whitney)

	Posttest Learning Activity	Posttest Learning Motivation	Posttest Learning Outcomes
Mann-Whtney U	0.000	69.500	116.00
Wilcoxon W	528.00	597.50	644.00
Z	-6.91	-5.97	-5.39
Asymp. sig. (2-tailed)	0.00	0.00	0.00

Learning Activity

There is a positive effect of the TPACK-integrated SaLDI learning model due to the advantages of the model. This includes the learning syntax, which is the first stage in the TPACK-based innovative Biology learning model, namely stimulation. Learners at this stage are faced with a problem or situation that can provide challenges and stimulate their minds. Stimulation functions to spur interest and attention to participate in examining a learning content. Appropriate stimulation can increase student motivation (Shin & Bolkan, 2021; Muhammad & Juandi, 2023; Widodo et al., 2021). Effective stimulation can encourage students to be more active and feel optimum motivation when learning (Bolkan, 2015; Sprevak & Smith, 2023).

Learning community is an important concept in the TPACK-integrated SaLDI learning model. Learners in this activity cooperate, collaborate, and help each other in constructing knowledge. The benefits of learning community are to train creative skills and train students' social interaction (Rabin, 2000). Learning community functions in creating a learning environment that cooperative between students and exchanges ideas. Learning community also helps students to provide mutual support among peers (Brouwer et al., 2018; Muhammad & Juandi, 2023).

The next stage in this learning model is discovery or searching. Discovery is essential in this learning model. Activities in this stage are learners conducting activities to find information related to the material being studied. Discovery benefits learners by supporting reflection, confirming effective teaching practices, and providing effective feedback on learning strategies (Wieman, 2014). Discovery serves to hone students' ability to discover new knowledge through investigation and exploration of the content learnt. Discovery-based learning can provide learning experiences and develop students' creative and critical skills (Bolkan, 2015; Mardhatillah et al., 2023). Discovery-based learning has proven that it can train creative critical thinking skills and find solutions to problems (Saggar et al., 2016; Ulger, 2018).

Inferring in the TPACK-integrated SaLDI learning model can be beneficial for learning. Through the inferring process, learners can develop analytical, critical and reflective thinking skills. Inferring can impact students in training them to make inferences from learning findings and provide experience for better decision-making (Yerimadesi et al., 2022). Inferring activities can be integrated with technology that can facilitate learning activities. Educators make digital media to improve pedagogical aspects, encourage constructive, innovative, interactive learning in learning (Loveless, 2011).

Table 1 displays the descriptive analysis of student learning activities which shows that learning activities in the experimental class are more prominent than those in the control. Therefore, it indicates that there is a difference in the level of learning activities between the two classes, where student learning activities in the experimental class are more optimal. Based on the standard deviation value, the experimental class has a smaller data spread than the control. Therefore, the data variation in the experimental class is narrower.

Table 2 shows that the frequency distribution and percentage of student learning activities. It explains that the dominant experimental class in the active and very active categories is higher in the control class. This is due to the optimal learning activities contained in the syntax of the learning model which indicates that students are actively involved in the learning process.

Based on Table 7, the mean rank value of the experimental class is higher in the control class (48.50 > 16.50), with a mean rank difference of 32.00. Table 8 shows the Asymp.sig. (2-tailed) of 0.00, which is smaller than 0.005, thus indicating a significant difference in learning activities between the experimental and control classes. This indicates a positive effect of the SaLDI learning model integrated with TPACK on student learning activities. In line with this finding, the use of SaLDI learning model that incorporates technology is proven to improve students' learning activities and outcomes (Kiviniemi, 2014). Innovative learning models are also known to enrich learning experiences and improve student learning outcomes (Suarsana et al., 2017).

Learning Motivation

The TPACK-integrated SaLDI learning model has a positive influence on student learning motivation. This is due to the existence of a social system, which includes: The learning environment in the TPACK-integrated SaLDI learning model is an environment that creates a learning atmosphere that supports collaboration and social interaction activities; Using a form of cooperative learning. Aims to create a learning environment that supports teamwork activities; Involves scaffolding activities that can enable learners to take responsibility for student learning progress; The concept of learning is democratic; The TPACK-integrated SaLDI learning model has a lively classroom filled with active learners and is the result of teacher to student and student to student interactions; and The TPACK-integrated SaLDI learning model contains learning that uses an LMS called saldi.id. This can support students' learning motivation.

Adnan et al., (2012) revealed that students must hone the importance of learning motivation as a need for students to understand that academic activities can provide a variety of good benefits. Learning motivation can be interpreted as a general trait (a characteristic that has universal meaning) or a situation-specific state (a specific condition). Meanwhile, learning motivation encourages students to be more dominantly active in learning activities in the classroom. Students with high motivation can be active in learning and improve their learning outcomes (Alioon & Delialioğlu, 2019).

Based on Table 3 displays a descriptive analysis of student learning motivation. It can be seen that the average learning motivation in the experimental class is higher in the control class. So that it shows the difference in learning motivation between the two classes. The experimental class shows more optimal learning motivation. In addition, the standard deviation in the experimental class is smaller than the control class, which means that the data variation in the experimental class is narrower than the control class.

Table 4 shows that the frequency distribution and percentage of student learning motivation. It indicates that the experimental class is dominant in the high and very high categories compared to the control class. This is due to the implementation of the TPACK-integrated SaLDI learning model using an LMS platform in the form of saldi.id which contains various features including class management, teachers, students, interactive learning activities and interesting learning resources.

The application of the SaLDI learning model integrated with TPACK has a positive effect on student learning motivation. Based on the data in Table 7, the mean rank of the experimental class is higher than that of the control class (46.33 > 18.67), which has a difference of 27.66. Table 8 shows the Asymp.sig. (2-tailed) of learning motivation, which is (0.00 < 0.005), indicates a significant difference in learning motivation between the experimental and control classes. This indicates that the TPACK-integrated SaLDI learning model has a positive effect on students' learning motivation. There is previous research supporting that the TGT learning model can increase students' motivation, by actively engaging them in group discussions and collaboration, which contributes to a significant increase in motivation and learning outcomes (Wu et al., 2013; Putri et al., 2023).

Learning Outcomes

The TPACK-integrated SaLDI learning model has positive effect because of its advantages. It is caused by the existence of a model support system consisting of syllabi, teaching modules, teaching materials, LKPD, assessments, laptops or smartphones, and LMS integration. This supports the application of the TPACK-integrated SaLDI learning model. There is a support system for the TPACK-integrated Innovative Biology learning model, which is divided into 2: online learning and offline learning. This learning model has an impact that can be felt by users. The intended impact is instructional and accompanying. The instructional impact is expected to improve learning outcomes, motivation, and student activity. As for the accompaniment, students can be proficient with the use of technology through the saldi.id LMS.

Based on Table 5 which presents the descriptive analysis of student learning outcomes, it can be seen that the average learning motivation in the experimental class is superior to the control. Therefore, it can be assumed that there is a difference between the two classes in terms of learning outcomes. The value of learning outcomes is more dominated by the experimental class, which indicates that the achievement

of learning outcomes in the class is more optimal. In addition, the standard deviation in the experimental class is lower compared to the control, which means that the variation of data in the experimental class is narrower.

Table 6 shows the frequency distribution and percentage of student learning outcomes. It indicates that the experimental class is dominant in the good and very good categories compared to the control class. This is due to the implementation of the TPACK-integrated SaLDI learning model using teaching materials containing various features including Bio-concepts, Bio-keywords, Bio-info, Bio-Challenge and LKPD containing assignments that train students' critical and creative thinking skills.

The application of the SaLDI learning model integrated with TPACK has an impact on improving student learning outcomes. Based on Table 7, the mean rank in the experimental class is higher in the control class (44.88 > 20.13), with a difference of 24.75. In Table 8, the Asymp.sig. (2-tailed) value of learning outcomes shows that (0.00 < 0.005), which illustrates a significant difference in learning outcomes between the experimental and control classes. Therefore, the SaLDI learning model integrated with TPACK has a positive effect on student learning outcomes. This is in line with the application of learning models that maximise student activity and motivation, thus contributing to the improvement of learning outcomes. For example, the application of the PBL learning model is also proven to improve student learning outcomes (Ramadhani, 2021). In addition, learning motivation is closely related to learning activities and outcomes, students who have high learning motivation tend to be more active in the learning process in class, which in turn will have a significant impact on learning outcomes (Maduretno et al., 2016).

Conclusion

Based on this research, it can be concluded that there is a positive effect of SaLDI learning model integrated with TPACK on the activity, motivation, and learning outcomes of Biology class XI students of SMA 14 Makassar. This was proven by the alpha significance value smaller than 0.05. Overall, the average activity, motivation, and learning outcomes of students in the experimental class were higher than those in the control class. Therefore, the TPACK-integrated SaLDI learning model consisting of syntax or learning stages of stimulation, learning community, discovery, inferring, social systems, reaction principles, and instructional and accompanying impacts is effective in improving students' activities, motivation, and learning outcomes. These findings reinforce the implication that the TPACK-integrated SaLDI learning model enriches the experience and optimises student engagement in learning activities. This is because the learning model can emphasise learning community, discovery and inferring. This can encourage students to be directly involved in the learning process critically and independently. In addition, stimulation, which is the introductory stage of learning, can encourage students to increase their connection and curiosity about the concept. The learning community stage can also provide space for students to interact and strengthen optimal collaboration and social skills. Further recommendations for this research are that the SaLDI learning model integrated with TPACK can explore the effect of this learning model at various levels of education and can be tested for effectiveness in other aspects. Therefore, the TPACK-integrated SaLDI learning model can make an important contribution to improving the quality of education for the future.

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Author Contributions

S.A.: conducting data collection, data analysis, and writing the manuscript; A. and A.A.: focusing on methodology and reviewing the writing.

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Conflicts of Interest

There is no conflict of interest.

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