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# نموذج مقترح لتصميم التعلم النشط في الفصول الدراسية المدمجة وأثره على تنمية الأداء الأكاديمي لدى طلاب كلية التربية النوعية

**اعداد**

محمود محمد حسين أحمد
أستاذ تكنولوجيا التعليم المساعد
جامعة جنوب الوادي

هيروشي يودا
مركز أبحاث دراسات الحوسبة والوسائط المتعددة
جامعة هوسا اليابان

محمد حسنين نيهال
مركز أبحاث دراسات الحوسبة والوسائط المتعددة
جامعة هوسا اليابان

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## مستخلص البـحث:

يتناول البحث الحالي دراستي حالة في مرحلة التعليم الجامعي، ويعرض هذا البحث نتائج دراستين تم فيهما تطبيق نموذج مقترح لممارسة التعلم النشط داخل الفصول الدراسية المدمجة أو الهجينة، ونموذج التعلم النشط قائم على أركان ثلاثة هي: النظرية والاستراتيجية والتكنولوجيا (AL-TST)، وتم تطبيق النموذج المقترح AL-TST للتدريس بالتعلم النشط لطلاب السنة الرابعة في إحدى الجامعات المصرية، واتبع البحث المنهج شبه تجريبية للتحقق من فعالية النموذج المقترح في الارتقاء بجودة العملية التعليمية، واعتمد البحث الحالي على الاستفادة من بنك المعرفة المصري في تعليم طلاب الجامعة (EKB)، وتم تصميم بيئات التعلم الرقمية لمقرري تطبيق تجربة البحث بحيث يتضمن تصميم كل مقرر تطبيقات مؤتمرات الفيديو وأدوات التعلم النشط التعاوني لتبادل الآراء والتقييم التكويني لتقييم المعرفة العملية لطلاب مجموعة البحث. أظهرت نتائج الطلاب في كلا المقررين تحسنًا كبيرًا في المهارات العملية. بالإضافة إلى تطبيق النموذج في مقررين في التعليم الجامعي تم عرض النموذج المقترح على مجموعة من الخبراء في تخصص تكنولوجيا التعليم واستطلاع رأي مجموعة من طلاب الجامعة حول خطوات تنفيذ التعلم النشط في بيئات التعلم الرقمية. وكشفت نتائج استطلاع الرأي أن تصميم محتوى التعلم بناءً على نموذج AL-TST يمكن أن يدعم الطلاب ليكونوا أكثر نشاطًا وفاعلية في التعليم الجامعي.


**الكلمات المفتاحية:** التعلم النشط، STEM ، الفصول الدراسية المدمجة ، التعليم العالي ، تكنولوجيا التعليم ، الأداء الأكاديمي.

# Explore the Role of Active Learning Model in Hybrid Classrooms to Improve Students` Academic Performance

**Mahmoud Mohamed Hussien Ahmed **, Hiroshi Ueda † and Mohammad Nehal Hasnine‡**

**Abstract:** In the context of higher education, this paper reports the findings of two case studies in which the active learning model for hybrid classrooms – Active Learning-Theory, Strategy, Technology (AL-TST) model – was adopted. In this study, the AL-TST model was used to effectively teach to fourth-year students at an Egyptian university. A quasi-experimental research method was used to investigate the efficacy of the model regarding students' learning improvement. The instructors used the university's e-learning platform linked with the Egyptian Knowledge Bank (EKB) to upload the main ideas and required detailed knowledge for each lesson. Both courses were taught using learner-centric content, digital

* Associate Professor, Instructional Technology Department at South Valley University, Qena, Egypt.

* Correspondence email: mahmoud.ahmed@sed.svu.edu.eg, ORCID: 0000-0003-3502-2886

† Full Professor, Research Center for Computing and Multimedia Studies at Hosei University, Tokyo, Japan.

Email: uep@hosei.ac.jp, ORCID: 0000-0001-6776-6500

‡ Associate Professor, Research Center for Computing and Multimedia Studies at Hosei University, Tokyo, Japan.

Email: nehal.hasnine.79@hosei.ac.jp, ORCID: 0000-0003-4761-4002

learning environments that included video conferencing applications, collaborative active learning tools for exchanging opinions, and formative assessment to assess students' practical knowledge. In both cases, the results demonstrated a significant improvement in students' practical skills related to the learning content design. Significant results were found in terms of practical skills assessment. In addition to the data collected, experts (N=3) and students (N=32) also provided feedback through a questionnaire. The results revealed that designing learning content based on the AL-TST model can support students to be more active in the classroom.

**Keywords:** Active learning; STEM; Hybrid classroom; Higher education; Educational technology; Academic Performance.

## 1. Introduction

Although most instructors in higher education do not come from backgrounds rooted in teacher education programs, they are looking to apply creative ways to provide flexible courses to diverse learners. Therefore, online and blended learning in higher education has been extensively studied as an appropriate solution for course delivery [1,2,3]. Recently, a strong enthusiasm for online education has been observed, and the number of online courses has increased. Consequently, the blended learning environment has been studied and adopted by many researchers to improve the academic skills of university students over the past three decades [4]. A hybrid classroom is a blended learning environment with numerous benefits. A hybrid classroom idiom refers to incorporate aspects of face-to-face and virtual instruction and it means that the students have to engage in online and in-class learning activities [5]. A hybrid learning environment could enhance students' personal and social engagement as a result of using comprehensive feedback that leads to improving teachers' knowledge and skills to teach and support students [6].

Syafril et al. found that it improves problem-solving skills in physics learning and helps learners understand and apply physics concepts [7]. Young et al. found that hybrid learning in higher education offers an adequate level of flexibility, cost-effectiveness, and rich learning resources by incorporating new technological advancements [8]. For successful hybrid learning, teachers must identify which technological tool is needed to meet the specific pedagogical goal and specify how it can be used to enhance students' abilities in the phases of the learning process [9].

Hybrid learning can help solve the IT infrastructure and internet connectivity access shortage [10]. However, a shortage remains in the application of some learning strategies, such as active learning in hybrid classrooms. Active learning is an instructional approach that can help university students in self-directed knowledge- and skill-building by doing, sharing knowledge, practicing problem-solving methods, and thinking critically [11]. Active learning in higher education can take on different forms of instruction, and offer different cognitive processes, more interaction and social collaboration among learners and other learning components, and deeper learning processing [12]. Enhancing active learning in higher education faces various barriers, including physical (e.g., lack of adequate classroom brightness and ventilation, classroom temperature, and architecture), institutional, pedagogical (e.g., creating and providing student-centered content), teacher-related (e.g., cannot use hybrid learning techniques appropriately), student-related, and technological barriers (e.g., availability of digital learning devices and internet connections) [13]. Designing a model for enhancing active learning in the hybrid classroom for higher education students can offer a solution for some of the challenges posed by such barriers.

The Active Learning-Theory, Strategy, Technology (AL-TST) model adopted in this study has three main components in a circular design model based on constructivist theory. Constructivist theory includes cognitive and social construction components that can be integrated to enhance collaborative learning through student-centered learning content. Its strategies consist of a list of active learning techniques that can be applied to enhance active learning in hybrid classrooms, and technologies can be used for delivering lectures, sharing content, and group discussions by connecting in-class and remote students. Although the suggested model was designed based on an effective learning theory, it still must be evaluated in various courses for higher education students.

To determine the impact of the AL-TST model, the following research questions were investigated:

RQ1: How can an active learning model be applied in higher education?

RQ2: What is the impact of using the active learning model, AL-TST to improve academic performance in an undergraduate STEM course?

RQ3: What is the impact of using this model to improve students' performance in the context of an undergraduate non-STEM course?

## 2. Literature Review

### *2.1. Students' Academic Performance in a Hybrid Classroom*

A hybrid classroom is a technology-based learning strategy that synergizes between physical learning (real) spaces, where students interact with their instructors face-to-face, and digital (virtual) learning spaces, where students interact through technology-based learning. The main goal of using hybrid classrooms in higher education is to design a learning context in which students can quickly move between digital and classroom-based learning activities. Louten and Daws found that learning in a hybrid classroom combines multiple modalities to achieve active learning and support individual, cooperative, and social learning processes [14]. Investing technology in the hybrid helps remove the physical constraints of traditional learning by de-emphasizing the drawbacks of face-to-face learning, e-learning, and distance learning. Despite its benefits, there is a lack of flexibility in using asynchronous or synchronous online learning based on learner preferences. Providing free choice while attending face-to-face or digital learning also poses a challenge [8].

Although hybrid classrooms have received considerable attention, especially in the wake of the COVID-19 pandemic, connecting teachers with learners remains a big challenge. Many teachers must also contend with passive students with low motivation while using only video conference applications in delivering the lectures. In times of pandemic, students had to stay at home and, as a result many of them had no access to traditional learning resources such as library. As such, universities encouraged students to use digital learning resources, such as academic digital libraries and knowledge banks. At the same time, all teachers were encouraged to upload the necessary learning resources to the official online learning platforms. However, at that time, students were not able to discuss their problems privately with teachers and classmates to gain a deeper understanding of their problems. To solve this issue, many teachers used online synchronous and asynchronous discussions and electronic brainstorming to deepen their students' understanding on the topics.

As a result, enhancing active learning in the hybrid classroom will increase learners' engagement, practicing sharing ideas for building their own experiences. As many universities now require teachers to use hybrid classrooms and apply social distancing among teachers and learners, designing and validating an active hybrid classroom learning model, such as AL-TST, has become necessary.

### *2.2. Stem and Non-Stem Education*

Science, Technology, Engineering, and Mathematics (STEM) education is an interdisciplinary approach to education that combines these areas. The traditional lecture format is an example of the conventional approach to passive learning in STEM higher education, where students listen to specialists convey their expertise. By contrast, when students engage in do things and think about the things they are doing is an example of practicing active learning in STEM higher education.

Utilizing STEM education can improve the development of qualified college students with 21st-century abilities [16]. In spite of this, researchers are always working to enhance STEM education. Previous research examined the ways in which the traditional education system uses active learning strategies to help students get better at fostering robust science learning [17]. However, research on how to improve active learning in STEM education in hybrid classrooms is needed. Furthermore, it is necessary to look into how the hybrid classroom in STEM education differs from hybrid classroom in non-STEM education in terms of promoting active learning in STEM and non-STEM subjects.

### *2.3. AL-TST MODEL*

The AL-TST model (refer to Figure 1) is an active learning model that was conceptualized to foster learning in higher education within a hybrid classroom. The proposed model has three main components:

1. Constructivism learning theory
2. Active learning strategy
3. Appropriate teaching and learning technologies.

In this model, constructivism theory includes cognitive instruction, which refers to improving learner experiences based on their prior knowledge, using student-centered content. Social construction reflects the importance of enhancing collaborative learning and supporting students in practicing such activities including one or more learning strategies is important for the model's implementation, and various strategies for active learning can be applied in hybrid learning environments, such as experiential learning, jigsaw discussion, role-playing, interactive lectures, writing minutes, self-assessment, forum theater, inquiry learning, brainstorming, peer review, triad group, think-pair-share, and pause for reflection [18,19]. The AL-TST model indicates that teaching can be delivered through face-to-face interaction in conventional lectures, as well as online interactive lectures. Teachers should encourage learners to practice self-learning and support students in their collaborative learning activities in all teaching venues. Learners should practice reflection and thinking about their learning activities, as well as engaging in conventional or digital discussions and brainstorming.

Active learning assessment based on the AL-TSL Model can be used as a learning step through constructive assessment. Learners should understand their weaknesses to resolve them and be enriched beyond the summative assessment that teachers conduct at the end of the course. Using the AL-TST model in a hybrid classroom, three types of assessments can be made: self-assessment, peer assessment, and teacher assessment. A formative assessment of learning outcomes and interaction measures is recommended. Formative assessment is a process that provides feedback and support during instruction such that teachers and students can adjust ongoing instruction and learning to improve achievement in the planned instructional outcomes [20]. Formative assessment is part of teachers' and learners' daily activities through dialogue. It enhances ongoing learning through observations, portfolios, practical demonstrations, paper-and-pencil tests, peer assessment, and self-assessment [21]. Formative assessment focuses on gathering evidence about student learning and aims to support students in being active, motivated, and proficient in learners. In the AL-TST model, formative e-assessment can be used to promote self-reflection by students taking control of their own learning. Formative e-assessment attributes are complex, consisting of a set of parameters, the potential for learner self-regulation, the potential for pedagogical modification, the scope for sharing outputs and ideas with peers, and the nature (extrinsic/intrinsic), frequency, role, and functions (monitoring, diagnosing, instructionally tractable) of feedback [22].

### *2.4. AL-TST Model for Improving Students' Academic Performance in Higher Education*

Based on the AL-TST model, a course in the hybrid classroom should have the following steps:

1. **Brainstorming strategies**: The main goal of practicing brainstorming strategies in a hybrid classroom is to discuss issues or practice learning activities individually or in groups and understand the lesson's main ideas included in the PowerPoint file. Such sessions can be conducted through face-to-face or digital meetings. Digital meetings can be arranged through asynchronous e-learning technology, such as discussion boards or blogs, or through synchronous e-learning technology, such as audio conferencing and chat apps. Moreover, other synchronous and asynchronous e-learning technologies, such as WhatsApp, social media apps, and

interactive whiteboards can be used to find ideas.

2. **Pause and Reflect:** Students are advised to take 1-5 minute breaks to reflect on what they learned in the synchronous meeting. They practice pause and reflection strategies to support them in understanding the extent of their learning, what shortcomings they have, and prepare questions around the obstacles they face while learning new experiences.
3. **Discussion:** Discussion is an essential strategy to enhance active learning. The instructor organizes the discussion about specific issues or issues suggested by students in their face-to-face or digital video meetings. Each learning group, consisting of 4-5 students, discusses the issues presented in class. These discussion activities can be held face-to-face, in class, or through chat applications such as WhatsApp or Facebook messenger. Video conference applications, such as Webex or Zoom, can also be used to support the discussion sessions.
4. **Project-based learning:** This strategy can be used to complete a project, such as writing a report, designing an instructional interactive board to teach a lesson, or creating a movie to solve a social problem that can enhance problem-solving.
5. **Self-assessment:** Self-assessment can be practiced by asking students to answer conventional questions, such as paper and pen quizzes, or digital quizzes, such as Class Marker, Quiz maker, and Google Forms. After the quiz, the instructor should share the model answer with the students through synchronous or asynchronous communication applications or present the model answer to them in

the classroom. Students also have the chance to discuss their answers with their team members or with the instructor.

6. **Collaborative assessment:** During class, students may practice collaborative assessment that can be used in project-based learning when the instructor asks students to make a group of 5-7 students to design a multimedia production project. Collaborative assessment requires specifying the required task in detail, the assessment criteria, the deadline for delivering the project or solving the problem, and the score students can obtain after finishing the project.

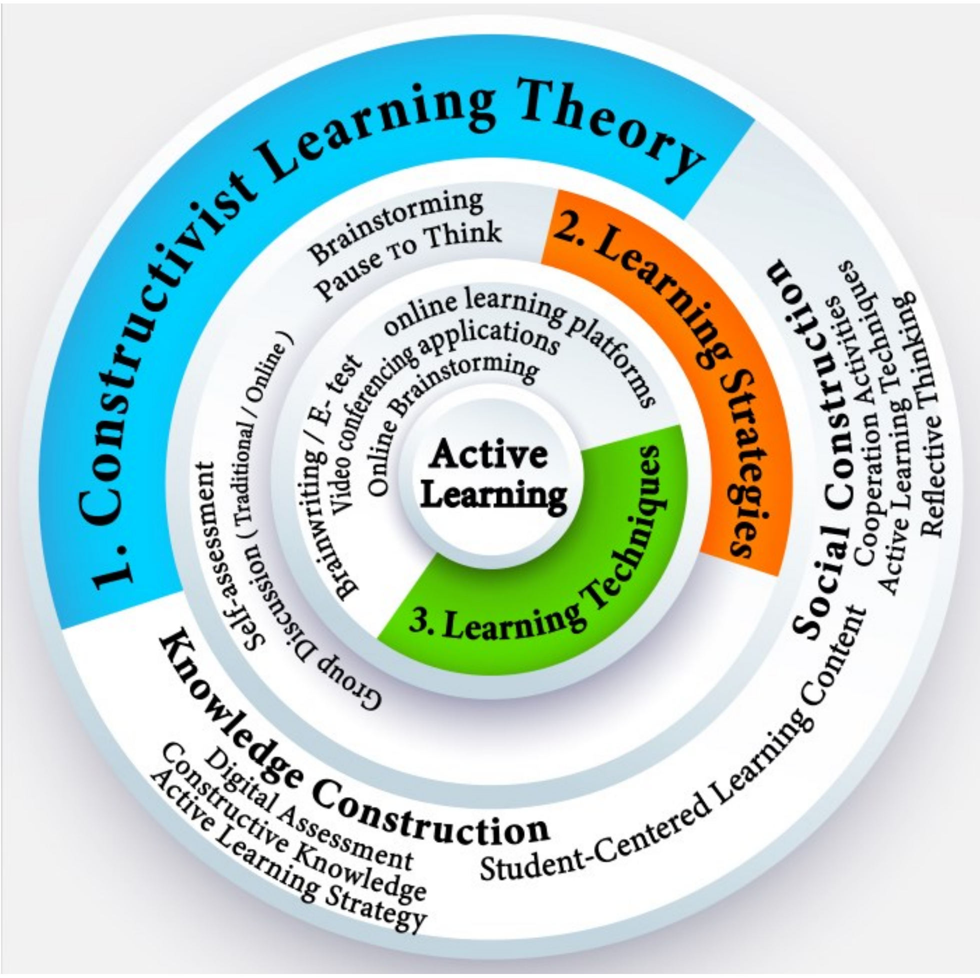

**Figure 1**. AL-TST model in a hybrid classroom [18]

## 3. Materials and Methods

### *3.1. Exploring students' academic performance data*

#### 3.1.1 Study site

To investigate the impact of the AL-TST model on achieving the learning objectives through the hybrid classroom, we focused on two undergraduate courses. The first course was the Instructional Boards Production, and is taught in the first semester for fourth-year students at the Faculty of Specific Education at South Valley University in Egypt.

The first course covers the following topics:

1. Introduction to instructional boards
2. Instructional pictures and graphics (their characteristics and how to read them)

3. The instructional chalkboard and its types (its importance, limitations, and methods of increasing its efficiency)
4. The flannel teaching board (design criteria, characteristics, importance, how to use it, and its advantages and disadvantages)
5. The pocket teaching board (design criteria, characteristics, importance, how to use it, and its advantages and drawbacks)
6. The electrical teaching board (design criteria, characteristics, importance, how to use it, and its advantages and disadvantages)
7. The magnetic teaching board (design criteria, characteristics, importance, how to use it, and its advantages and disadvantages)
8. Interactive promotion boards and how to use them to improve learners' positive behavior
9. Interactive instructional boards (specifications and how to use).

The second course was multimedia production and is taught in the first semester for fourth-year students at the Faculty of Mass Communication at South Valley University in Egypt. This course covers the following topics:

1. Multimedia (including its meaning, background, and features)
2. Interactive multimedia
3. Elements of multimedia
4. Multimedia authoring software and the application of multimedia in media
5. Multimedia development team
6. Multimedia production guidelines
7. Multimedia presentation style
8. Use of multimedia and its useful applications

9. The role of multimedia in improving mass communication and the challenges of multimedia production

The Instructional Boards Production and Multimedia Production courses were chosen since they are both fourth-level courses. STEM courses can be represented by a multimedia production course. Students use technology while taking the multi-media production course. On the other hand, the Instructional Boards Production course is a non-STEM course. Furthermore, both courses use various methods of assessment, which might help us understand how the proposed model affects diverse assessment approaches. Although one course is STEM and the other is non-STEM, both aim to improve learners' abilities in visual content creation, visual thinking, and identifying the essential message that learners must convey to their audience. In addition, there is a significant similarity in assessing students' performance in both courses. Assessment in both courses includes evaluating students' performance in the final project, a practical exam that measures students' skills, and a final paper and pen examination to examine students' knowledge of the course.

The experiment was conducted over nine weeks during the first semester (November 7, ٢٠٢٢ to January 2, ٢٠٢٣) at South Valley University, with the first course taking place at the faculty of specific education and the second at the faculty of mass communication. Over nine weeks, every week students in both courses had to attend two hours of lectures whether face-to-face (in total 8 hours) or online lecture (in total 10 hours) and four hours of training sessions in whether face-to-face (in total 16 hours) or online lecture (in total 20 hours). In total, all students attend 18 hours as a lecture and 36 hours as practical training sessions. Moreover, attending 70% of learning hours was a compulsory requirement for passing the course. Student performance on the various evaluation methods and learning activities was collected based on the experimental protocol approved by the South Valley University Ethical Approval Committee.

3.1.2. Participants

There were 40 participants in the multimedia production course (females = 22, **male** = **18**, average age = 20.83, SD = 0.89); however, two were excluded for withdrawing from the course. There were 23 participants in the instructional board course (females = 8, **male** = **15**, average age = 21.26, SD = 1.01).

3.1.3. Experimental design

We applied a quasi-experimental design namely, One-group Pretest-Posttest design to measure the adapted AL-TST model in a hybrid classroom to enhance active learning in various learning contexts and to support higher education students in achieving their learning objectives. Both courses were designed based on the AL-TST model in a hybrid classroom, as shown in Figure 2. The participants studied in either one of the compulsory courses in which a hybrid learning approach was used. Students of both courses spent a week at the university using the traditional face-to-face learning method. When using the face-to-face method, students spend two hours for learning the theoretical knowledge in the classroom. In the teaching board production course, students had to spend four hours in the instructional media lab to learn the teaching board production skills. Whereas, in the multi-media production course, students had to spend three hours in the computer room to learn multimedia production skills.

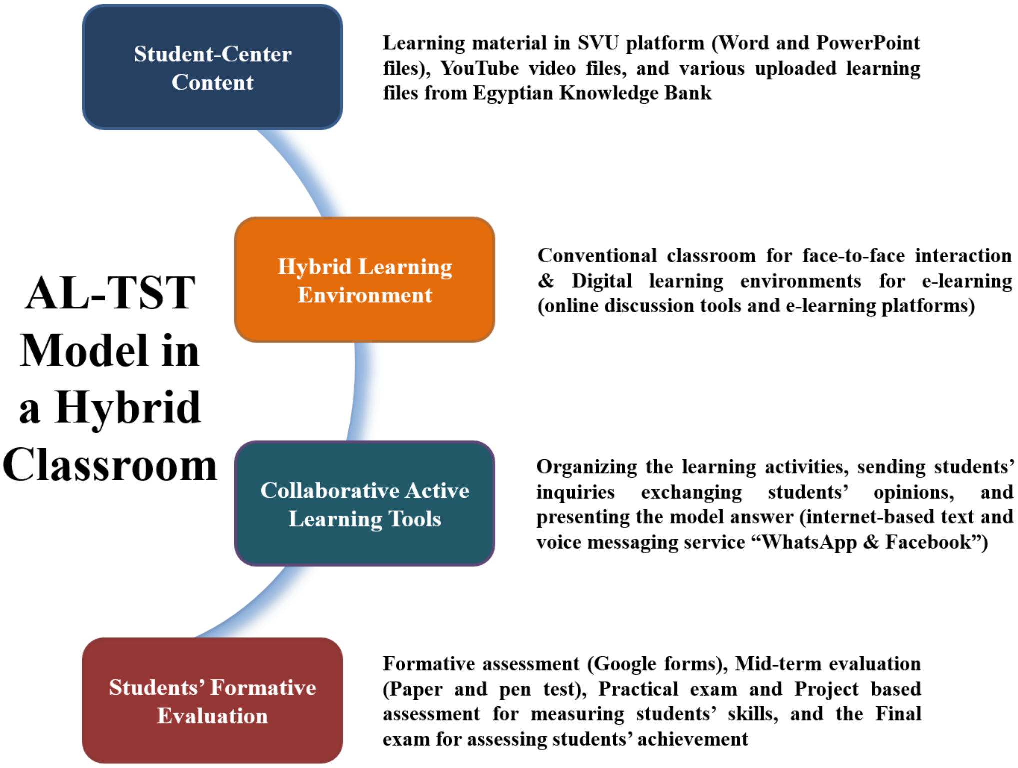


**Figure 2.** AL-TST model in a hybrid classroom

After a week at the university, students were invited to study for another week at home via the Internet. At home, students attended two-hour lectures using the video conferencing app to learn the theoretical knowledge portion of the course and two hours to learn practical skills in both courses. As mentioned earlier, students learned about the course weekly throughout the semester using face-to-face or digital learning tools.

To design the Instructional Boards Production course and the Multimedia Production course, the teacher of each course created student-centered learning content (learning syllabus) and identified the main ideas and required knowledge or skills for each lesson using PowerPoint. At least three days before each class, the PowerPoint files for the lectures and practical training were uploaded to the e-learning platform (http://app.svu.edu.eg/ecourses/faculties3.aspx*) in addition to YouTube videos that were presented in detail to assist in learning practical skills. The prepared learning activities that were required to pass were uploaded to Google applications such as Google Drive, Google Forms, and Google Docs.

Before the class started, students received a textbook as learning material and had the opportunity to review the lecture materials. They could read the lesson's ideas and had various opportunities to improve their experiences by relating those ideas to their prior experiences around the lesson. They could improve their abilities and prepare for the questions posed during class by studying the lesson through learning resources available on the internet in addition to the textbook and uploaded e-learning materials. Students had to attend one lecture per week and were instructed to be active in class.

During the class, students had to perform the assigned learning tasks and were asked to answer a quiz that was designed to include

* http://app.svu.edu.eg/ecourses/faculties3.aspx

some individual tasks in addition to the collaborative ones. To achieve the best answer to the quizzes, the teacher asked students to build their own learning teams consisting of 3-5 students. Students collaborated with their team members to understand the topic, discuss the answers, practice brainstorming strategies to deliver their learning tasks, and improve their skills on the topics included in the lesson's PowerPoint. A pause for reflection strategy was used to collect new information and revise the answers. By doing this, students had the opportunity to deeply reflect on the answers and the quality of the learning tasks. The pause for reflection sessions lasted from 3-5 minutes. Afterwards, the students were consulted by the teacher through a WhatsApp group. They could also use the Egyptian Knowledge Bank (https://www.ekb.eg ), which consists of a wide range of free learning resources related to the lesson.

Students who could not finish their learning tasks in class had enough time to complete and deliver the tasks within three days, starting from the end of the learning session in the classroom. All students were free to collaborate with their team members to perform the learning tasks or individually before or after the learning session. The professor sent feedback to each student within 24 hours of students receiving their learning tasks. After the students delivered their learning tasks, the instructor shared the model answers with all students within two days before starting the next class. WhatsApp was used to help students obtain more information from their professors or their team members. During the course, the professor regularly sent messages to all students to motivate them to not give up until they finished the course with high grades.

Assessments in both courses were designed based on the following steps. The coursework grades that students could achieve were calculated based on a self-assessment method with a quiz component designed using Google Forms. The midterm exam was also a self-assessment in which students were asked to answer exam questions. After the students finished their midterm exam, the professor presented the model answers to the students, and they had the opportunity to discuss their answers with them. The professor also asked students to compare their answers with the shared model answers provided within the WhatsApp application or by the projector in the classroom.

The project-based assessment method was used as a collaborative assessment. The teacher asked each group of students to prepare their project, which was a video file in the multimedia production course and an instructional board in the instructional board production course. Students were also asked to perform learning tasks for each lecture: writing a report or designing an instructional board in the instructional board course, and preparing one multimedia type such as sound, video, or text in the multimedia production course.

As the two courses were student-centric, the teacher of both courses provided the learning syllabus and various learning resources, answered student inquires, delivered feedback, presented the model answers, and discussed the presented answer. Moreover, the teacher organized the learning activities that students should practice inside and outside the class. At the end of the two courses, all students attended a final exam. Therefore, students had to do both the constructive and final assessments.

According to the university procedures, evaluations need to be done by multiple teachers. In both courses, three instructors designed the final and oral exams. There are two instructors to assess practical skills; one is the main teacher of the course, and the other is an assistant with more than seven years of experience in teaching the course. Two assessment tools are used to support learners' practical skills, including a practice exam and a final project assessment.

3.1.4. Findings from the academic performance data

**Improving academic performance in the multimedia production course**

A one-sample statistical t-test was applied to understand students' grades distribution in terms of the various outcomes between student achievement using the AL-TST model in a hybrid learning environment and the proficiency level needed to master the learning content. Student proficiency can be enhanced if students score more than 80% in the assessment, which was the case in this study at 81%. Across the various assessment methods, encompassing the midterm, project-based assessment, practical exam, and final exam, we compared student grades in the final test (post-test) with one grade expressing the proficiency level. Figure 3 shows the overall results in various assessment types in the STEM course.

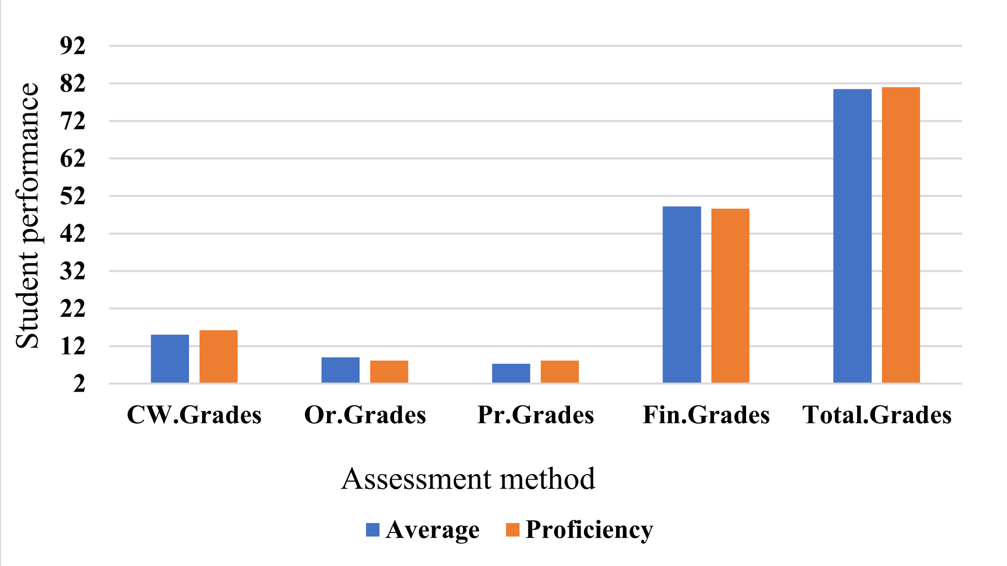


**Figure 3.** Assessment types in a STEM course (i.e., multimedia production course)

The midterm exam was conducted in the middle of the course, after five weeks. It was a paper-and-pen exam consisting of 20 items, with a maximum grade of 20 and a minimum of 0. T-test is used to examine the difference between the unknown population abilities, which can be represented by the sample mean in the current study, and a specific value that reflects mastery of the course [23]. However, the number of participants is not lower than 30 participants, many statistical references indicate that the number of participants in the current study for both courses is adequate sample for applying t-test [24]. Besides, the current in the current study the authors recruited all participants who accepted to volunteer in the current manuscript. And all participants were fresh students in the similar rage of age and the gender among participates does not affect the result according to [24]. The exam results demonstrated significantly better grades (M=15.03, SD=1.52; $t(37) = 4.77$, $p < 0.01$) with a large effect size in Cohens' test ($d > 0.8$). Table 1 and Table 2 show the one-sample statistics and one-sample t-test results of the midterm grades, respectively.

**Table 1.** One-sample t-test for students' grades in Multimedia Production course

| Assessment methods | N | Max | Mean | Std. Deviation | Std. Error Mean | Test Value | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Lower | Upper |
| **Midterm** | 38 | 20 | 15.03 | 1.51 | 0.25 | 16.2 | − 4.77 | 37 | 0.001* | − 1.17 | − 1.67 | − 0.68 |
| **Project** | 38 | 10 | 9.00 | 0.23 | 0.038 | 16.2 | 23.86 | 37 | 0.001* | 0.90 | 0.82 | 0.98 |
| **Practical exam** | 38 | 10 | 7.26 | 0.83 | 0.13 | 16.2 | −6.23 | 37 | 0.001* | − 0.84 | −1.11 | −0.57 |
| **Final exam** | 38 | 60 | 49.21 | 2.93 | 0.48 | 16.2 | 1.28 | 37 | 0.21 | 0.61 | −0.35 | 1.57 |
| **Total** | 38 | 100 | 80.50 | 3.63 | 0.59 | 16.2 | − 0.85 | 37 | 0.40 | − 0.50 | −1.70 | 0.69 |

Note. * indicates $p < 0.01$

After studying the basic required knowledge and skills of the course, students were asked to design a collaborative multimedia project (movie). Before the practical and final exams in the eighth week, students were asked to deliver their projects. The maximum grade was 10. The main criteria for assessing the delivered projects were a clear project message, logical presentation of the idea, project design, editing, and the quality of the multimedia used. After comparing students' results with the project design proficiency level, significantly better grades were obtained ($M=9.00$, $SD=0.23$; $t(37) = 23.86$, $p < 0.01$). Table 1 present the one-sample statistics and one-sample t-test results of the project grades, respectively.

At the end of the course, students attended a practical assessment that was designed to ask students to perform tasks related to designing a multimedia file using the Adobe After Effect application. The practical assessment results showed a significant improvement in student performance in terms of the required multimedia production project ($M=9.00$, $SD=0.23$; $t (37) = 23.86$, $p < 0.01$) with a large effect size in Cohens' test ($d > 0.8$). Table 1. indicate the result of the one-sample statistics and one-sample t-test analysis of the practical exam grades.

In the final exam, students' scores did not show a significant difference in terms of improving their multimedia production performance ($M=49.21$, $SD=2.93$), $t (37) = 1.28$, $p > 0.05$. Table 1. shows the result of the one-sample statistics and one-sample t-test analysis of the total grades. Regarding total grades, no significant difference was found in terms of improving their multimedia production performance ($M=80.50$, $SD=3.63$; $t (37) = 0.85$, $p > 0.05$).

The results demonstrate that students studied the fundamental knowledge related to the topics before the class began and actively participated in the collaborative learning activities. While collaboratively preparing the video file, discussions (and e-discussions) were very active as students exchanged their experiences with each other. The AL-TST model's components helped students engage when they attended class, both physically and virtually. The model also helped students become cognizant of the required learning activities, such as producing a multimedia project, supporting tourism in Egypt, changing unhealthy habits (e.g., smoking), and recording interviews. The students were active in presenting the final product to the teacher and appeared more confident in themselves.

Improving student performance in the instructional board course

Various assessment methods were applied in the instructional board course. Figure 4 shows the overall results in various assessment types in the non-STEM course.

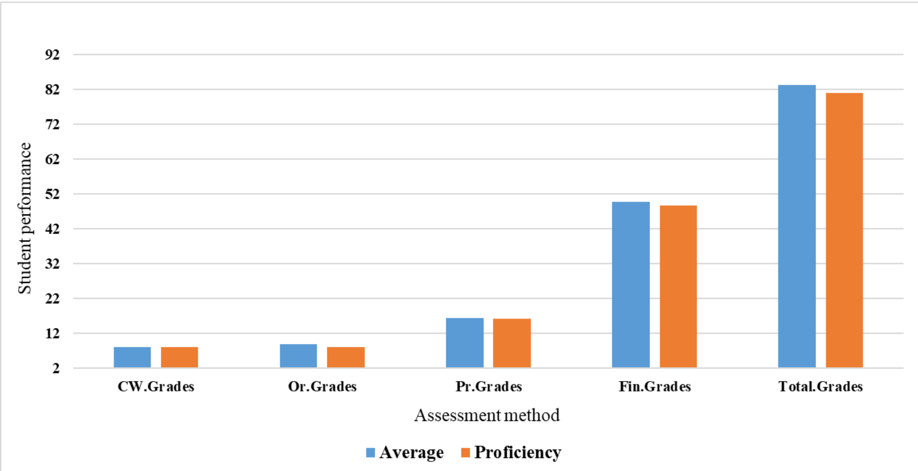


Figure 4. Assessment types in a non-STEM course (i.e., instructional board course)

We compared student grades in the assessment (post-test) with the proficiency level indicated to be 81% of the maximum grade. The assessment methods included the following: Coursework applied as a simple quiz or task focused on assessing student performance in one session. It was designed as either an e-test or paper-and-pen test. One or two grades were specified for each coursework assignment, with a total score of 10. The results of this examination demonstrated an insignificant improvement ($M = 8.13$, $SD = 2.44$, $t(22) = 0.06$, $p > 0.05$). Table 2 shows the results of one-sample statistics and a t-test on the coursework grades.

An oral test was performed before the course ended. The students were asked to attend an oral exam regarding their skills in designing instructional boards. The maximum possible score was 10. Comparing students' results with their proficiency level in the oral test showed significantly better grades ($M=8.96$, $SD=1.72$; $t(22) = 2.39$, $p < 0.05$) with a large effect size in Cohens' test ($d > 0.8$). Table 2. presents the results of one-sample statistics and a t-test on the oral exam grades.

At the end of the course, the students attended a practical assessment. The practical assessment was designed to ask students to perform tasks related to the design of the instructional board. The practical assessment results demonstrated no significant improvement in student performance in producing the instructional boards ($M=16.52$, $SD=3.40$; $t(22) = 0.45$, $p > 0.05$) with a medium effect size in Cohens' test ($d > 0.8$). In table 2., we show the results of an one-sample statistics and a t-test on the practical exam grades. In table 2., we present the results of an one-sample statistics and a t-test of students' final exam grades. In the final exam, students also showed a non-significant differences in improving their skills in producing instructional boards ($M=49.70$, $SD=3.14$; $t(22) = 1.67$, $p > 0.05$).

Regarding final exam grades, no significant difference was found in improving students' achievement in producing the instructional boards ($M=49.70$, $SD=3.14$; $t(22) = 1.67$, $p > 0.05$). Table 2., shows the results of one-sample statistics and a t-test on the total grades. Regarding total grades, no significant difference was found in improving students' skills in producing the instructional boards ($M=83.30$, $SD=7.56$; $t(22) = 1.46$, $p > 0.05$).

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

**Table 2.** One-sample t-test for students' grades in Multimedia Production course

| Assessment methods | N | Max | Mean | Std. Deviation | Std. Error Mean | Test Value | t | df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Lower | Upper |
| Course Activities | 23 | 10 | 8.13 | 2.44 | 0.51 | 16.2 | 0.06 | 22 | 0.95 | 0.03 | -1.02 | 1.08 |
| Oral Exam | 23 | 10 | 8.96 | 1.72 | 0.36 | 16.2 | 2.39 | 22 | 0.03* | 0.86 | 0.11 | 1.60 |
| Practical exam | 23 | 20 | 16.52 | 3.40 | 0.71 | 16.2 | 0.45 | 22 | 0.65 | 0.32 | -1.15 | 1.79 |
| Final exam | 23 | 60 | 49.70 | 3.14 | 0.65 | 16.2 | 1.67 | 22 | 0.11 | 1.10 | -0.26 | 2.45 |
| Total | 23 | 100 | 83.30 | 7.56 | 1.58 | 16.2 | 1.46 | 22 | 0.16 | 2.30 | - 0.96 | 5.57 |

Note. * indicates $p < 0.05$

### *3.2. Survey findings from expert opinions and learners' impressions*

#### 3.2.1. Participants

Group one consisted of three experts in the educational technology major. They are professors at South Valley University (where the experiment was conducted) and have been working as full-time instructors at various universities for more than ten years. They have also worked as educational technology researchers for more than 20 years. They received Ph.Ds in Instructional Technology at least 13 years ago and worked as teachers in higher education both inside and outside Egypt, teaching hundreds of graduate and post-graduate students. They have also published more than 15 scientific papers on various topics in the domains of education and instructional technology. They also have prior experience in teaching the two courses we chose for the current study.

There are just three participants in the current study since the participants should be well-versed in active learning, hybrid classrooms, and higher education. Finding specialists with a broad variety of experience in these many educational domains who can give the authors 20 minutes to explain the suggested model and go into extensive detail about how to implement the suggested model was not an easy task. Simultaneously, the specialists ought to have prior experience as instructors in the same university and teach courses for similar students who participate in study one, as this can shed light on how the investigation study's findings can be enhanced in future research.

Group two consisted of 32 students (females = 13, average age = 20.56) registered in the faculty of specific education at South Valley University, all of which used a hybrid classroom strategy in all courses that were taught to them. The learners consist of students in both STEM and non-STEM courses who agreed to answer the questionnaire after studying the entire course and delivering all the learning tasks. Moreover, the participants attended a workshop on enhancing active learning in the hybrid classroom, introducing the AL-TST model.

3.2.2. Experts' opinions and learners' impressions

The experiment in Study 1 focused on surveying the experts and learners to understand the main reasons behind the results. The authors designed a survey questionnaire consisting of 19 questions scored on a 3-point Likert scale to collect learners' impressions, following the guidelines of Jia et al. and Rogers et al. [6,7]. A total of five university staff members reviewed the questionnaire. A professor and a teaching member of the Department of Educational Psychology and three members of the Department of Educational and Information Technology at South Valley University, were invited to test the effectiveness of using the questionnaire to measure the effectiveness of the proposed model. Each reviewer gives their feedback, and the author revises the questionnaire based on the reviewer's feedback.

Reliability of the questionnaire was measured by Cronbach's alpha reliability coefficient. We surveyed 65 university students who were using hybrid learning during the Covid-19. The students did not participate in the experiment. The scores of the students in the questionnaire were collected. The Cronbach's alpha reliability coefficient was found to be 0.84, and this value ranged from 0.8 to 0.89, indicating the reliability of the questionnaire. The reliability of this questionnaire is good. Therefore, the questionnaire can be used among teachers and students to measure the effectiveness of the AL-TST model. Accordingly, active learning experts answered the questionnaire and provided the authors with more details regarding the AL-TST design. The applied questionnaire included nineteen items. All participants were also asked to answer an open question to provide feedback or comments about the suggested model.

3.2.3. Questionnaire, findings, and discussion

To elaborate on this survey, 20 of the 32 learners answered “adequate” to the question, “It can lead learners to apply the attributes of constructive learning” as adequate. In contrast, 12 learners indicated that the model needs improvement. The students responded to the survey by choosing the most appropriate answer according to their opinion. They didn't pay attention to providing more feedback to the author. One reason could be that they did not have enough experience with the instructional design models. On the same question, all three experts indicated that the model needs improvement. Hence, mixed feedback was found from both the learners and experts.

In addition to answering the questionnaire, all experts provided some valuable comments as follows:

**Expert 1's comments on the efficacy of the model**

- The model is general in terms of active learning practices

- The learning steps in the model can be freely chosen by the teacher, but it would be clearer if the order of learning steps is allocated
- Self–assessment is a major stage in the model, and it should be easily applicable if self–assessments correlate with the learning situation
- Learning analysis can be used as a process for fostering active learning in the hybrid classroom

**Expert 2's comments on the efficacy of the model**

- The model was designed based on a circular layout. The circular layout can provide a wide range of freedom in applying the AL–TST model, but it cannot help users specify the starting point in the model
- The model is simple and can be easily applied in various learning contexts; however, it does not cover all dimensions of active learning strategies
- The first version of the model has two types of line styles (dashed and solid lines), and it is not clear why researchers used two line styles. Therefore, minor design improvements to the current version (Figure 1) have been suggested
- The model's components should somehow interact with each other, but in the current model the connections are unclear
- The color–coding in the model is hard to interpret without further instructions

**Expert 3's comments on the efficacy of the model**

- Learning technologies in the model should not be mentioned as applications because there are hundreds of applications, and users should have a chance to use any suitable technology

- The model could be more flexible in adopting other learning theories, such as Vygotsky's sociocultural theory (Mutekwe, 2014), not just constructivist learning theory
- The learning strategies in the suggested model must be improved upon by adding web-based learning strategies, learning inquiries, and learning discoveries
- Self-assessment should be replaced with self-regulated learning.

### 3.2.3. Critical analysis of the expert opinions

Regarding the experts' critiques, Expert 1. suggests that "The model is quite general;" however, we aim to design a general model that helps teachers easily use it. Expert 1 indicated that "The learning steps in the model can be freely chosen by the teacher, but it would be clearer if the order of learning steps is allocated;" however, we aim to design a simple model that teachers can adapt to various learning situations. Expert 1 also indicated that "Self-assessment is a major stage in the model, and it would be easily applicable if self-assessments correlated with the learning situation." Because the model is designed to be general, correlating self-assessment with each specific learning situation will not change the model from a general learning model to a specific one. Another note was, "Learning analysis can be used as a process for fostering active learning in the hybrid classroom." Due to the sudden COVID-19 crisis, the model was quickly developed to adapt to learning needs. We agree with the expert that learning analysis is an important step, and we will add this step to the new version of the model.

Expert 2 also indicated that "It does not cover all dimensions of active learning strategies;" however, it was designed to cover many – not all – common active learning strategies that can be used in hybrid classrooms (auhtor et al., 2020). Finally, Expert 2 indicates that the "Model's components should somehow interact with each other, but in the current model the connections are unclear." The current version (Figure 1) contains three nested stages that are completely interactive with each other, as well as a new color coding reflecting each component of the model.

Regarding Expert 3's critiques, the expert suggests that "Learning technologies in the model should not be mentioned as applications because there are hundreds of applications and users should have a chance to use any suitable technology." Therefore, minor design improvements to the current version (Figure 1) were suggested. Expert 2 also indicated that "The model could be more flexible to adopt other learning theories, such as: Vygotsky's socio-cultural theory" and that "The learning strategies in the suggested model need to improve by adding a web-based learning strategy, learning inquires, and learning discoveries."

Expert 3 indicated that "Self-assessment should be replaced with self-regulated learning," although we believe that self-regulated learning is more suitable for individual learning with its many strategies, including organizing and transforming, goal setting and planning, seeking information, keeping records and monitoring, environmental structuring, self-consequences, rehearsing and memorizing, seeking social assistance, reviewing records, and self-evaluation. Self-assessment is a sub-stage of self-regulated learning; therefore, self-assessment should not be replaced with self-regulation.

## 4. Discussion

Active learning is a learner-centered strategy that has become popular since the 1990s in the context of traditional learning environments. Active learning is a pedagogical expression that refers to engaging learners in learning by doing and thinking about what they are doing to achieve learning outcomes [3]. Many prior studies have reported that active learning can enhanced conventional classroom learning, leading to various benefits for higher education students, such as improving their achievement in financial education through the use of active learning in lecture-based classrooms [8]. For example, using active learning to study Lisp programming is more effective than using traditional instructional learning methods because of its ability to enhance some types of active information processing in the learner. In courses that demand highly detailed knowledge, learners can become lost in the instructional details, and active learning on a digital platform can reduce documentation and produce superior transfer performance in various situations [26]. Moreover, using active learning strategies, such as small group exercises and peer review in advanced mathematics classes, for example, can provide students with a large volume of information and help them appreciate the opportunity to express their views, leading to energetic discussion with a more participatory and exciting learning environment [27].

Digital instructional technologies can also offer a suitable learning environment to enhance active learning. Nowadays, hundreds of digital learning applications and systems can be used in the classroom to practice active learning processes both inside and outside the classroom. Consequently, these technologies can improve the quality of learning in hybrid classrooms. In this study, various instructional technologies were used, including student-centered content shared through South Valley University's e-learning platform. The teachers in both courses encouraged learners to practice self-learning, collaborative learning activities, and reflection and to prepare and share questions about the obstacles they found while studying outside the classroom using digital applications, such as Facebook messenger, email, WhatsApp, and Zoom. Students shared their questions and practiced conventional discussion and brainstorming inside the classroom and through digital discussion and brainstorming using Zoom.

And the mentioned in general e-learning tools can support higher education students in their learning and prior studies agree with this result such as [25] that indicates using active learning based on the synchronous and asynchronous online classes support the higher education's students to improve their social presence. In addition to [25] which highlighted the importance of using online video while applying active leaning strategy in teaching undergraduate students for increasing higher education students' abilities of Skim the learning content and that lead to help students to finish studying the course faster.

Hybrid learning can add new value to the class, making the learning environment suitable for enhancing active learning in higher education. Through the hybrid classroom, learners can use various active learning methods. For example, to teach the basics of computer programming by combining digital tools with effective active learning methods, such as kinesthetic learning activities, game competition, discussion, and hands-on labs [3]. Learners could receive a fun and interesting learning experience, and the learning environment could encompass a variety of students with divergent goals that would be encouraged to continue studying the course [3].

Recently, active learning has become an important part of effective computer science pedagogy, helping learners engage in computer science learning for undergraduate and post-graduate studies [28]. Higher education students have various abilities, motivations, skills, and attitudes. Consequently, it is important to consider learner differences when creating an academic course. Synchronous and asynchronous interaction using internet communication and interactive multimedia can support learning in higher education. Flipped classrooms are a type of hybrid classroom that can solve the challenge of learner differences and enhance equity among students [19]. Therefore, the active learning process should be integrated with problem-solving strategies and instructional technology tools. Online learning experiences should also provide authentic experiences using adaptive learning contexts that enable learners to immediately apply the knowledge they have gained [29].

Atkinson et al. demonstrated that enhancing active learning through an online learning environment requires suitable content and assessments [29]. Their research also indicated that learning content should be learner-centered, and learning steps should be outcome-driven with intensive assessment methods. Active learning on virtual learning platforms should provide individual learning experiences and applied learning strategies to motivate learners, with content that includes authentic experiences that are easily applied in virtual spaces [29]. This could make active learning an appropriate teaching strategy that enables students to learn individually or in groups to enhance their learning outcomes.

Prior studies have provided evidence about the impact of using technology for improving student skills in information technology courses. For example, in an artificial intelligence course, an interactive Java application called "collective bin packing" offered a puzzle-like exercise to present the bin packing problem. The active learning exercise encourages students to think about algorithms by involving them in learning activities, taking turns to make an individual action or discussing in groups to practice problem-solving. Using such an application to practice active learning is a suitable way to deliver artificial intelligence courses [28].

Using online learning technology, such as Google presentation, supports students in applying their prior knowledge to construct new ideas. Google presentations and web-based quizzes or exams can be used in college classrooms to enhance web-based learning.

Consequently, learners like learning assignments and appreciate the creation of learning materials [30]. The teachers in both courses noticed that using PowerPoint presentations can free up class time for discussion or practicing more activities rather than providing information delivery, which can lead to engaging learners in learning.

In this work, we explored the opportunity to state that research question number one may be the primary research question in the current study besides being a research question. "How can an active learning model be applied in higher education?" is the query. The current manuscript's research methodologies seek to determine whether the proposed paradigm may be used to improve active learning in hybrid classrooms. Consequently, we attempted to implement the recommended approach in the typical classroom setting. To allow teachers to engage in active learning even when they employ their typical teaching strategies. Teachers who like active learning may put in less effort and incorporate learning activities into a structured learning approach.

The research question, "How can an active learning model be applied in higher education?" is addressed as follows: (1) they looked over several references to outline the main actions that need to be taken to improve active learning in hybrid classrooms at the higher education level. (2) investigate through two courses how the learning actions according to the suggested model can enhance active learning in the hybrid classroom in higher education. (3) suggest the model with actions in order and details that can be followed to achieve the research goal. (4) Ensure that the model can be applied in many other courses by asking the experts and testing the suggested model in two various courses.

Improving student performance in higher education in a hybrid classroom that uses an active learning strategy depends on providing meaningful learning that can facilitate access to learning materials, applying learning experience, and designing evaluation methods in a suitable environment [31]. Communication and collaboration among students pose challenges to enhancing active learning in online environments; however, using hybrid learning could support such students in improving their achievements in a project-based learning course design [11]. Therefore, students could improve their skills in the course because it can provide a real learning environment that helps them apply their experience on the same platform.

## 5. Conclusion

The AL-TST model could be a solution for implementing active learning in higher educational institutions, leading to enhanced student-centered learning. Sociocultural theory can also be integrated to enhance active learning in hybrid learning environments. For the initial version of the AL-TST model, it clearly can be used for collaborative learning and improving students' social interactions and abilities. Based on students' grades on the midterm exam, project-based assessment, and practical exam, we can conclude that using the AL-TST model in multimedia production courses for higher education students improves academic performance. Although the effectiveness of using the AL-TST model in the multimedia production course remains, the result is related to the assessment method. The conventional method of assessment using pen-and-paper tests did not improve student achievement. It is a passive interaction to assess student achievement, and the teaching method should be consistent with the assessment method for significant results. Furthermore, the learning material should be related to the teaching strategy and learning technologies. In the instructional boards course, learners studied the content and produced instructional boards that were digitized only in the design stage. As a result, the coursework achievement in this course was insignificant because student activities were separated from the digital learning environment. In addition, a practical exam was designed by adjusting the materials to produce each type of instructional board, which was not practiced in the digital learning environment. Thus, the course choices for using the AL-TST model should have some criteria to attain better results.

## 6. Recommendation and limitations

However, many studies focused on enhancing active learning in a conventional classroom; adapting the AL-TST model in future studies may provide a chance to investigate how technology is set up in the physical and digital classroom for enhancing active classroom and methods of promoting teachers' roles in the hybrid classroom that aims to achieve active learning. Future research should study the best methods for organizing instructional resources, identifying learner characteristics, and adapting more active learning strategies to deliver instruction at a distance. In addition, it enhances equity and equivalence among students in active learning in various higher education contexts through integrating the four dimensions of the AL-TST model.

The current study has some limitations in its results. First, the current study focuses on understanding the role of the AL-TST model for undergraduate-level students. To generalize the result, we aim to test the model in a broader group of students (such as graduate level and K-12) in the future. Second, the number of participants and experts needs to be increased. In this work, three experts provided us with feedback. Although the number of experts (N=3) is low, they have diverse experiences adopting active learning methods in higher education. Therefore, we could rely on their feedback. However, we aim to increase the number of experts in the future. Third, the experiments were conducted quickly, and extending the time to investigate the role of the AL-TST model can provide more deep results.

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