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Smart learning model in technical and vocational education training with webcast technology

Yasdinul Huda *, Putra Jaya, Elfi Tasrif, Hafiz Elmi
Universitas Negeri Padang, Indonesia.
* Corresponding Author. Email: yasdinul5330@ft.unp.ac.id

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ABSTRACT

This research aims to develop an e-learning strategy for the industrial revolution 4.0 era by developing an innovative and adaptable TVET learning model using Webcast technology. This approach highlights the blended learning model developed as a smart learning model featuring a balance between synchronous and asynchronous learning using webcast technology. Research and development method is used in this approach. The model design is done by literature study and focus group discussion with experts and academicians. The model effectiveness trial results were measured with an experimental design (using the one-group pretest-posttest and posttest-only method with nonequivalent groups). The results of developing a smart learning model of TVET webcast technology describe: (1) How the learning rules are used; (2) How to connect with webcasting technology; and (3) What are the stages and steps of the webcasting-based smart learning model? The proposed model approach allows for simultaneous learning interactions in synchronous and asynchronous classes in various locations, thus triggering student engagement in learning activities and enhancing different learning styles, ways of thinking, and problem-solving skills.

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INTRODUCTION

Quality education is seen as important in the current competitive environment of the Industrial Revolution 4.0. According to Triyono (2017), Industrial Revolution 4.0 or the 4th World Industrial Revolution includes social inclusion, human life, robotics, quantum computing, biotechnology, 3D printing, vehicle automation, internet and virtualization and has underlying technological characteristics. Science. System. with global cooperation. This condition applies to professional courses that prepare graduates for professional activities, especially for the role of teacher (Triyono, 2017). In order to improve the quality of education, various studies are conducted. These include the best teaching strategies; effective and efficient (Picard, 2004; Shinn, 1997), the best teaching methods, reflection and reflection (Biesta, 2009; Effiong & Igiri, 2015; Kapi et al., 2017; Lazar, 2015; Navaneedhan, 2010; Westbrook et al., 2013).

To address the issue of quality education, educational strategies that use technology-enabled devices seem to be the right solution. Expanding access to quality education through online learning technology is the best solution. Online learning in Indonesia, known as distance learning or *pendidikan jarak jauh* (PJJ), has now become an integral part of Indonesia's educational landscape

and provides access to education for the community (Mukarromah & Wijayanti, 2021). This situation opens up opportunities and challenges for universities for active distance learning in the 21st century.

To answer the rapid development of the times in the 21st century, learning must be planned in such a way as to achieve 21st-century competencies. According to Kusmawan (2014), classroom characteristics that describe competencies in the 21st century fulfill four characteristics that distinguish it from the previous century, namely: Integrating digital communication into learning, collaboration, critical thinking and creativity, and innovation. The inclusion of digital communication as a key area of 21st-century learning skills provides the basis for the importance of research in this discussion. Issues related to equity and democratization of education and the expansion of access to quality education at all levels of society have long been a concern of the government and are one of the main areas of the National Research Master Plan 2017-2045 and the Strategic Plan of Universitas Negara Padang 2020-2025. The model provided aims to support the realization of the strategic plan and Universitas Negeri Padang, especially as an IT-based learning development subject in the field of educational and educational technology excellence.

Issues related to the expansion of access to quality education to all levels of society through PJJ have been addressed wisely by the government through various legal instruments that have been issued, including Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 109 of 2013 concerning the Implementation of Distance Education in Higher Education, Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System and Government Regulation Number 17 of 2010 concerning Management and Implementation of Education which was later amended by Government Regulation Number 66 of 2010 and Law Number 12 of 2012 concerning Higher Education. Legally based on the Regulation of the Minister of Education and Culture Number 109 of 2013 distance learning aims to provide higher education services to groups of people who cannot attend face-to-face education and expand access and facilitate higher education services in learning.

Thus, it can be interpreted that PJJ is an education system that has the characteristics of open, independent, and complete learning by utilizing ICT and/or other technologies and/or integrating learning in higher education. In its development, the distance education system greatly benefits from the development of media, information, and communication technology that can bridge the need for mass education. Higher education then strengthens the implementation of online learning (synchronous) through the Regulation of the Minister of Research, Technology and Higher Education of the Republic of Indonesia No. 51/2018. The rapid development of technology has given rise to a flexible and smart distance education model, and we introduce it as Smart Learning. It is called smart learning because distance education has a learning strategy that is able to open access to education for anyone, anywhere, and anytime by crossing the boundaries of space and time and overcoming various socio-economic barriers.

In order to build various intellectual talents in students, proper smart learning implementation techniques are required, as shown in Figure 1. This strategy should combine online and face-to-face approaches both separately and together, as shown in Figure 1, to enhance the knowledge and skill capacity of students with diverse abilities. 1, to enhance the knowledge and skill capacity of students with diverse abilities. In this study, through 2 scenarios of teaching methods, the learning model is designed to adopt a blended learning model that balances synchronous and asynchronous online face-to-face learning together.

This intelligent learning model can be achieved through modeling the trial use of webcast technology in an intelligent classroom learning environment. The proportion of instruction in each form varies widely and isstrongly influenced by the role of the trainer in facilitating learning. E-learning has developed into a learning process, not limited to a static and independent one-way learning process. The e-learning learning environment indirectly encourages students to learn more actively (Gumilar & Hermawan, 2021). It has undergone a series of studies at Universitas Negeri Padang, particularly at the faculty of engineering. As shown in Figure 2, the electronics engineering department, one of the departments in Faculty of Engineering, Universitas Negeri Padang (FT UNP) as a vocational education institution, already has the supporting devices and environment for smart classrooms (Huda et al., 2019, 2021; Huda & Hayadi, 2017; Novaliendry et al., 2020; Rukun et al., 2019).

Figure 1. Synchronous and Asynchronous Learning Models by AverExpert (Hastings, 2018)

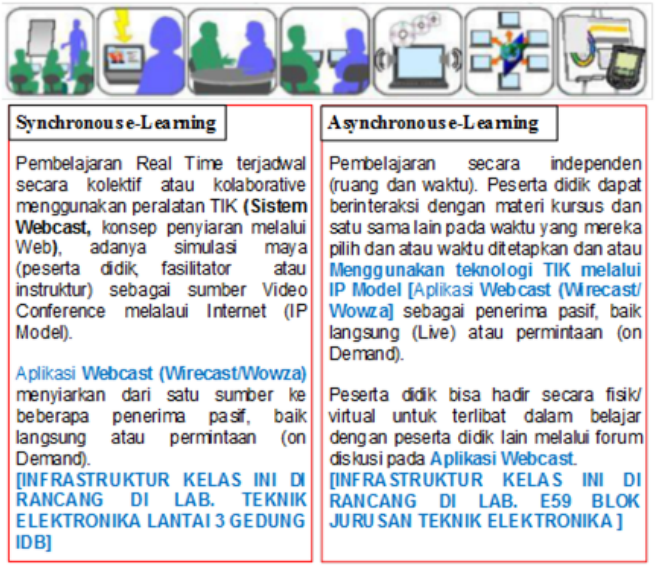

Figure 2. Synchronous (Live) dan Asynchronous (on Demand) Learning

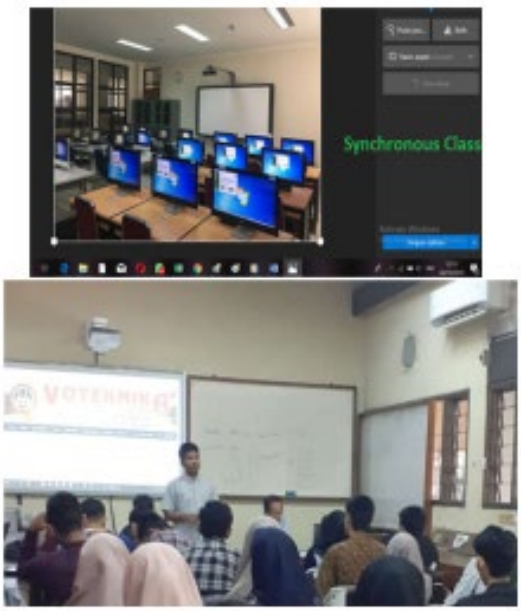

Figure 3. Implementation Webcast Technology in the Department of Electronics FT UNP (Rukun et al., 2019)

This approach highlights a blended learning model developed as an intelligent learning model featuring a balance between synchronous and asynchronous learning by using student smartphone or tablet webcasting technology. The outcomes of the development of the webcast technology TVET intelligent learning model are revealed through the research questions (1) How the learning rules are used; (2) How to connect to webcasting technology; and (3) What are the stages and steps of the webcasting-based intelligent learning model?

The proposed model approach allows for simultaneous learning interactions in synchronous and asynchronous classrooms at various locations, thus triggering student engagement in learning activities and enhancing different learning styles, thinking and problem-solving abilities.

RESEARCH METHOD

This type of research is development research (Educational Research and Development, R&D), with the direction of finding and developing learning models as intelligent learning. In the model trial conducted after revising the model based on the analysis of the limited trial results and feedback, the number of participants involved was 1 lecturer and 45 students (natural work setting in 1 synchronous class and 2 asynchronous classes). This field trial was conducted in a real learning situation by forming a practicum learning class so that developer interaction with related experts was needed.

The measurement of the results of the model effectiveness trial following the experimental design is shown in Figure 4.

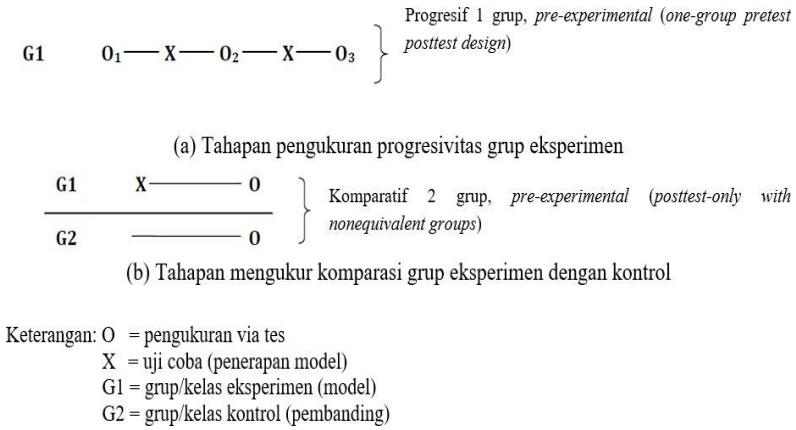

Figure 4. Experimental design for Smart learning development model in TVET with webcast technology (Creswell, 2009)

The concept of smart learning models using webcast technology can be applied to both asynchronous and synchronous classes in different locations. Asynchronous learning allows students to engage with course material at their own pace, while synchronous learning involves learners and instructors being in the same place at the same time. A blended approach that combines both types of learning can be effective in improving the online learning experience.

FINDINGS AND DISCUSSION

How learning rules are used?

In order to be orderly and successful during the online learning process in this Smart Learning Model, surely ethics/attitudes are needed that can be understood and agreed upon by the participants of online learning, as can be seen in Table 1.

Table 1. Ethics/Attitudes Needed by The Participants of Online Learning

No.	Ethics/Attitudes	Explanation
1	Setting the Device Up Properly	Make sure you have access to and are properly set up with computer hardware, USB headphones, and microphones while preparing synchronized online sessions.
2	Explanation	Be proactive in approaching teachers for assistance with coursework issues and setting up IT for technical problem-solving.
3	Keep Your Options Open	Be open to sharing your own opinions while also listening to other's opinions about your work and the work of your fellow participants, even if they offer unfavorable advice from time to time.
4	Taking Time	The capacity to think things through before replying to others.
5	Respond quickly and in a clear manner.	Respond to emails sent by other participants and engage in synchronous and asynchronous discussions with them.
6	Be Honest in Your Comments	Be receptive to feedback from other participants and don't assume that it's negative; rather, assume that it's constructive and encouraging.
7	Discipline and Responsibility	By giving yourself the time to read, participate in, and explore the course material, you discipline yourself and are in charge of controlling your own learning.
8	An association that is sincere, respectful, and open	When corresponding with other participants, maintain an open, polite, and sincere relationship.
9	Control Your Time	By giving yourself the time to read, participate in, and explore the course material, discipline and self-management of your own learning are emphasized.
10	Limit each other while remaining open to alternative debate topics.	As long as they don't distract from anyone's work, side conversations are encouraged during synchronous sessions in this course.
11	Concentrate the conversation on recent references	Focus on recent citations from books or journal articles, usually from the past 5 to 7 years, unless the chosen older work is frequently cited by more recent works.

Source: (International Labour Organization (ILO) & United Nations Educational Scientific and Cultural Organisation (UNESCO), 2002; Mahazir et al., 2015)

How to connect to webcasting technology?

To connect to webcast technology, you must use a webcast application or encoder. Webcast encoders are available from online webcast manufacturers for a range of uses, such as webinars and education. Wowza, Zoom, Wirecast, Youtube, Skype for Business, Meet with Google Hangouts, Cisco WebEx, GoToMeeting, and Join.me are all listed but not discussed in this section because it explains how the encoder is used. The following tasks must be completed as connection preparations for the webcast to be a successful learning tool before, during, and after the webcast event (Burns, 2020; Yunus et al., 2006).

Step 1: Pick Your Audio and Video Sources

The first step in streaming for the first time is choosing a video source as a content source that can be converted to digital format. Use a camera with an output like HDMI, HD-SDI, or Component, if possible. Depending on how complex it is (multiple cameras), the intended broadcast may use one video source or a number of video streams that switch back and forth. Choose a professional camera and an isolated microphone that can be placed in the best location if you want better results. For audio, this can come from inside the camera or from a different audio capture device, like a standalone microphone.

Step 2: Choose an Encoder

An encoder for turning audio-video content into a format that can be broadcast over the Internet is called webcasting. Encoders can be based on hardware or software. The encoder will always receive input from the video and audio sources. The encoder will then be broadcast to the associated streaming URL for the chosen shipping method. For instance, the webcast used must support RTMP (Real Time Messaging Protocol) if the video solution only accepts this protocol.

Step 3: Choose a Delivery Method

Choosing a delivery method depends on the purpose of the content distribution. If the webcast needs to be secured, the content provider (lecturer) has the option to limit access. Security is a concern because the restriction is particularly severe if the webcast must be internal (personal) only. The sending method must be flexible enough to accommodate a large number of participants, and the security system becomes scalable. Because flash is typically incompatible with cellular, RTMP-based encoders will only be able to reach participants who have a Flash-based player and will exclude participants who are using cellular.

Transcoding is necessary to make the flow mobile device compatible and to reach these participants. Adaptive streaming bitrate, a method of presenting different bitrate and resolution combinations of video content based on the connection speed of the viewer, ensures that participants can watch content at their connection speed. Current mobile-friendly delivery methods like HLS (HTTP Live Streaming) include this technology as a component.

Step 4: Secure the Internet Connection

The key action is protecting an Internet connection. Webcasts need a dependable and quick internet connection. The caliber of the broadcasted content affects how quickly a connection is required. Securing upload speeds that are roughly twice as fast as the intended content bitrate is a good general rule. The upload speed must be 2 Mbps if you want to stream at 1 Mbps. A faster connection speed will be needed if you use a service that calls for sending higher bitrates through the encoder. Although in this case all the bitrates must be added, speed is based on quality. For instance, if someone provided inputs of 2.5Mbps, 1Mbps, 500 kbps, and 250 kbps, the combined speed would be 3.25Mbps. A 6.5 Mbps upload speed will therefore be necessary. This is why it's advised to use cloud transcoding to produce additional bitrates for live content.

Step 5: Configure the Webcast Encoder

Configuring the webcast encoding is the final step. This step depends on the sending strategy and connection speed.

What are the phases and steps of the webcasting-based smart learning model?

The nine facilities and learning steps that make up the offered smart learning model are shown in Table 2. The formal limited trial was conducted for 4 (four) meetings (1 synchronous class in the laboratory and 2 asynchronous classes). The initial meeting was used to explain the concept and implementation of the model along with the learning modes contained therein. The researcher assumed that the participants (students) who had been selected as test subjects had a fairly good initial knowledge of informatics systems, because they had attended the specified conditional lectures.

After the limited trial and efforts to ensure the readiness of the smart learning model for expanded trials, the researchers measured the perceptions of lecturers and students on the effectiveness of learning on the model. By using the instrument, a description of the lecturers' perceptions or assessments of several aspects of the implementation of learning on the model is summarized as Table 3.

Table 2. Smart Learning Model on Webcast Technology

Activity Number	Learning on Webcast Technology	Activities on the Smart Learning Model	Literatur Study
1	Lecture online easily: Simple ways for lecturers and teachers to schedule online lessons	By clicking "webcast," lecturers can easily convert any presentation into an online lecture program. They can also save time during the preparation process by using the special recording feature of Encoder Webcasting.	Yunus et al. (2006)
2	Online lectures are available anywhere, at any time: Access to lectures anywhere and at any time with an ID code	When using webcasts, students can access their course's online lecture rooms from any location at any time as long as they have their ID code.	Shah (2023); Simamora (2020)
3	Online lecture room settings: customize the learning page (online lecture room) lecturer	Lecturers can create learning pages (online lecture rooms) for students before landing pages for online lectures begin, so when they arrive early for the lecturer webcast, they will still know that they are in the right online lecture room.	Wallick et al. (2004)
4	Active and interactive learning: digital notes and interactive frequency ask questions (online)	Allows for active learning. During the webcast, students can post digital comments and ask the lecturer, teacher-student, student-student, or student-lecturer questions.	Amoudi and Tbaishat (2023); Basar et al. (2021)
5	Review of the live event: Assessment of learning outcomes	Students can assess their progress in synchronous online college learning, their level of participation during and after the webcast, and other student activities.	Hokanson et al. (2019); Raouna, (2022)
6	Pause and replay lecture material: DVR (encoder webcast) playback and pause controls	Students can find the last point of the video watched (video material followed). Students can rewind their live feed on DVR in a similar fashion to TiVo and then immediately find it again.	Ahmad and Begen (2009); Solari (2000)
7	Online lecture index that can be searched: Video recording index for search	Students will not lose course material. Every word uttered by a lecturer or instructor is automatically indexed by a webcast and displayed on the screen in a student broadcast, ensuring that the student webcast recordings are complete.	Chang et al. (2007); So (2002)
8	Live streaming multi-camera for learning	Webcasts deliver high-quality multi-camera playback on any device without the need for third-party browser plugins when using HTML5 or higher.	Duhamel, (2023); Mattamala et al. (2021)
9	Streaming live video to a smartphone or tablet	Anywhere in the world, students can participate in live webcasts of online lectures. On Android and iOS, users can stream live videos to their mobile devices using the webcast application.	Chaves et al. (2017); Gomes (2019)

Table 3. Lecturer Assessment of Learning Effectiveness

No.	Aspect of Assessment	Assessor (Lecturer)				Score (%)	Average Score
		A	B	C	D		
1	Validity aspect	12	11	12	12	97,92	3,92
2	Reliability aspect	4	3	3	3	81,25	3,25
3	Objectivity aspect	11	10	11	11	89,58	3,58
4	Practicality aspect	7	7	7	7	87,50	3,50
	Total Average					87,50	3,50

In general, lecturers assessed that the smart learning model with webcast technology developed can improve students' abilities. It allows for simultaneous learning interaction in synchronous and asynchronous classes at various locations, triggering student engagement in

learning activities and increasing different learning styles, thinking and problem-solving skills. Lecturers also assessed that the stages and steps of implementing learning in the model and all its devices would be easy to implement (the practicality aspect almost reached 90%). Similarly, the aspect of the suitability of the model to the efforts to achieve the objectives and the accompanying impact of the model itself. On the other hand, lecturers have little doubt about the suitability of the learning and strategies offered by MPIT-SMC, with a variety of other courses (reliability aspect at 81.25%). Although the average score of this aspect is 3.25, in terms of model development, this still needs attention.

Table 4. Student Assessment of Learning Effectiveness

No.	Aspect of Assessment	Rater						Score (%)	Average Score
		A	B	C	D	E	F		
1	Validity aspect	7	7	6	7	7	7	85,42	3,42
2	Reliability aspect	3	2	3	3	3	3	70,83	2,83
3	Objectivity aspect	11	11	12	11	11	11	93,06	3,72
4	Practicality aspect	6	8	6	6	7	7	83,33	3,33
	Total Average							83,16	3,44

In line with the lecturers, the assessment of students who were the subjects of the model trial also gave more or less the same results. The most prominent aspect of student assessment is the objectivity of learning. This aspect is considered very important considering that students as learning actors give a very positive perception (93.06% or an average score of 3.72) of the model. Students also assessed that the model is quite practical and able to improve student competence as its main target (synchronous and asynchronous classroom learning interactions in various locations, triggering student involvement in learning activities and improving different learning styles, ways of thinking, and problem-solving abilities), although they have doubts about the suitability of the model for various courses. Table 4 illustrates this more fully. In general, from the students' point of view, the model is considered effective for improving students' competencies with a good level of practicality and efficiency.

CONCLUSION

In conclusion, the analysis of the effectiveness of the model has proven that the results of the development of the TVET smart learning model using webcast technology are important to pay attention to several stages: (1) How the learning rules are used; (2) How to connect with webcasting technology; and (3) What are the stages and steps of the webcasting-based intelligent learning model. The model approach proposed in Table 2 is proven to be able to trigger learning interactions simultaneously in synchronous and asynchronous classes in various locations, trigger student involvement in learning activities and improve different learning styles, ways of thinking and problem solving abilities according to the data in Table 3 and Table 4. This research is supported by previous studies that also explored how webcasting can be used to increase student engagement, improve learning outcomes, and support different learning styles (Chen et al., 2021; Cheung et al., 2021; Dimitriadou & Lanitis, 2023; Li et al., 2016). The future direction of vocational education research related to smart learning with webcast technology, it is important to consider the technical challenges and constraints that may be associated with the use of webcasting, such as unstable internet connections, accessibility, and the need for appropriate hardware. Furthermore, it relates to learning strategies: which includes research on how to effectively integrate webcasting technology into different learning strategies, such as blended learning, flipped classroom, and distance learning.

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