ELINVO (Electronics, Informatics, and Vocational Education), November 2023; vol 8(2): 201-213
ISSN 2580-6424 (printed), ISSN 2477-2399 (online) DOI: https://doi.org/10.21831/elinvo.v8i2.57845

The Flipped-Classroom Instructional Procedure Development and Its Implementation Effectiveness in Improving Procedural Knowledge Learning Outcomes at Vocational High Schools

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ABSTRACT

The students' number limitation in a classroom and the compression of face-to-face time challenge teachers to present practical learning scenarios to achieve learning objectives. This study aims to develop student learning procedures with the flipped classroom (FC) instructional model and determine its use in improving student learning outcomes. The research was conducted at a public information technology vocational high school in Malang, East Java Province, Indonesia. The FC instructional procedure development approach is based on the ADDIE (analysis, design, development, implementation, and evaluation) phase. The FC instructional procedure was developed in conjunction with a constructivist instructional strategy, consisting of five primary stages: (1) perception, (2) exploration, (3) restructuring, (4) implementation, and (5) review and evaluation. FC instructional procedure effectiveness was tested using the Randomized Pre-test and Post-test Control Group Design research design. The control and experimental groups consist of 30 students with randomization. The research found that the learning outcomes of the experimental group (EGLO = 70.00) were greater than those of the control group (CGLO = 64.30). The normalized gain index of the experimental groups (g = 0.50) was more significant than the control groups (g = 0.41). The conclusion is that the FC procedures with a constructivist approach have proven more effective in improving student learning outcomes.

Keywords*:* computing education, flipped classroom, procedural knowledge, learning outcomes

INTRODUCTION

The enactment of the distance learning system automatically familiarizes the world of education with blended learning. Blended learning is a learning system combining face-to-face learning with online learning that utilizes technology[1], [2]. A blended learning system can overcome classroom learning time limitations by optimizing learning outside the classroom. Blended learning has two advantages related to flexibility, namely time flexibility and location flexibility [3]. Learners can access online materials at their own pace and schedule, allowing for better time management. As online components can be accessed from anywhere with an internet connection, learners have the flexibility to study remotely [2], [4], [5]. This advantage can solve physical classroom problems related to the limited number of students accommodated and scheduled.

One of the instructional models of blended learning is the flipped classroom (FC), which allows students to explore new knowledge through self-study at home before actively deepening the material in the classroom with the teacher's guidance[6], [7]. Self-study activities carried out by students can be in the form of watching learning videos or animations of materials, reading literature documents from e-books, and studying material articles published on websites or presentation slides. Many research results have scientifically proven that FC positively impacts learning outcomes [8]–[14]. The problem faced by current research is that it cannot answer what the formalization of standardized syntax or FC stages looks like, and the research results are still being carried out in the general subject context. It must be acknowledged by all parties that not all subjects have suitable characteristics to be supported by FC [15], [16].

Forcing the implementation of FC on subjects without considering the limited control over FC is not wise in managing the learning process. One disadvantage of the FC model is that it places a significant responsibility on students to independently engage with pre-recorded information or materials before attending in-person classes [17]. The success of the FC relies on students' self-discipline and motivation to prepare adequately outside of the traditional classroom setting. This approach may pose challenges for students who struggle with time management, lack access to necessary technology, or require more guidance and structure in their learning [18]–[20]. Additionally, teachers must carefully design and curate pre-class materials to ensure they are effective, and there may be concerns about unequal access to resources among students. The FC model, while offering benefits such as increased class interactivity, can result in varying levels of preparation among students, potentially hindering the overall effectiveness of in-person collaborative activities.

There is still a knowledge gap that needs to be filled based on current research trends and the advantages and disadvantages of using FC models. This knowledge gap is an FC model that is scientifically proven to be able to be implemented while having a good impact on subjects with specific knowledge type characteristics. Formalization of the learning process is needed because current research still uses a variety of processes in the experiments carried out [15], [21], [22]. Then, the context related to the type of knowledge in the subject also needs to be specified because there are differences in character between conceptual and procedural knowledge content [23]–[28]. Mastery of conceptual and procedural content knowledge cannot possibly be accommodated with the same FC learning process. Descriptive and theoretical information students dominate conceptual knowledge need to understand, while procedural knowledge is dominated by information on steps or skills students must master.

Procedural knowledge is paramount in vocational education as it forms the bedrock for skill acquisition and application in various trades and professions [29]. Vocational education is inherently hands-on, focusing on preparing individuals for specific careers and trades [30], [31]. Procedural knowledge equips learners with the practical expertise to perform tasks, operate machinery, and navigate real-world challenges within their chosen field. In vocational settings such as healthcare or information technology, students must not only understand the theoretical aspects but also master the step-by-step procedures and techniques essential for success on the job. This practical know-how gained through procedural knowledge not only enhances the employability of individuals but also ensures they can seamlessly integrate into their chosen professions with a strong foundation of applicable skills [23], [25]. Vocational education, therefore, places a premium on procedural knowledge to bridge the gap between theoretical understanding and hands-on competence, preparing individuals for the demands of the workforce in a diverse range of industries .

Unfortunately, research related to FC is still dominant in the health sector, and the research sites are primarily in higher education [8], [15], [16], [32]–[45]. FC research in these two fields shows that FC positively impacts students' mastery of knowledge. It could be a research potential where there needs to be scientific evidence related to FC in the context of vocational high schools. It should be noted that vocational high schools are another form of vocational education that applies in Indonesia and targets high school students. Vocational high schools play a crucial role in Indonesia by addressing the country's economic and workforce needs [31], [46]. Indonesia is characterized by a diverse economy emphasizing various industries, including information technology, agriculture, manufacturing, tourism, and services. Vocational high schools provide specialized education and training that directly aligns with the demands of these industries, producing skilled and job-ready graduates [47], [48]. These institutions offer a practical and hands-on approach to learning, equipping students with the specific technical skills and knowledge required in their chosen fields. By emphasizing vocational education, Indonesia can bridge the gap between academic knowledge and practical application, fostering a workforce that meets the demands of the evolving job market [31]. Additionally, vocational high schools reduce unemployment by preparing students for specific careers, promoting economic development, and addressing the needs of industries that form the backbone of Indonesia's economy [48].

In the context of information technology (IT), vocational high schools in Indonesia play a critical role in addressing the country's growing demand for skilled IT professionals. Information technology is rapidly evolving, and there is a pressing need for individuals with hands-on, practical skills in programming, network administration, cybersecurity, and software development [49]. Vocational high schools specializing in IT provide students with specialized training, equipping them with the technical expertise and practical knowledge required to navigate the dynamic IT landscape. These schools contribute directly to Indonesia's efforts to build a robust digital economy by offering a curriculum that aligns with industry standards and emerging technologies [49]. Moreover, vocational IT education fosters innovation by nurturing a workforce capable of developing and implementing technological solutions. As Indonesia aims to position itself as a digital hub, vocational high schools focused on IT are instrumental in producing a skilled workforce that can meet the demands of the rapidly advancing technology sector, driving economic growth and competitiveness on both national and international scales.

Implementing FC in information technology vocational high schools experiences several practical dilemmas [50]. One Indonesian vocational high school in Malang, East Java Province, could be used as a model for this dilemma. The practical dilemma is the reality where implementation shows that FC provides good efficiency in saving time in the classroom and makes student study hours more flexible. However, the quality of FC implementation is still difficult to control because each teacher has a different implementation style. Several teachers already have the same understanding regarding FC, but some teachers still have a different perspective regarding FC and still think that the FC they understand is correct, even though that is not the case in reality.

If based on the results of studies related to the potential weaknesses and advantages of FC implementation, research potential related to FC, and the strategic role of Indonesian vocational high schools in the field of information technology, this research aims to develop instructional procedures for implementing FC in the context of vocational high schools in the field of information technology. The research also seeks to determine the effectiveness of these instructional procedures in improving the student's learning outcomes. Learning outcomes indicate student success in learning the material studied through evaluation activities [50], [51]. The success and effectiveness of a learning system or procedure applied in the student learning process can be seen through its learning outcomes. Therefore, the effectiveness of learning procedures with the FC model can be found through experiments that compare the learning outcomes of students who apply FC instructional procedures with those who follow face-to-face or direct instructional procedures.

METHODS

This research was carried out in the FC instructional procedure development stage and the experimental stage for the procedure's effectiveness [52]. The research process is visualized in Figure 1. The development phase uses a qualitative approach to developing procedures. The experimental stage used The Randomized Pre-test Post-test Control Group Design, which involves the experimental and control groups given treatment. This study adapts the instructional development design of the ADDIE model, which consists of five regular stages, namely: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation [53], [54].

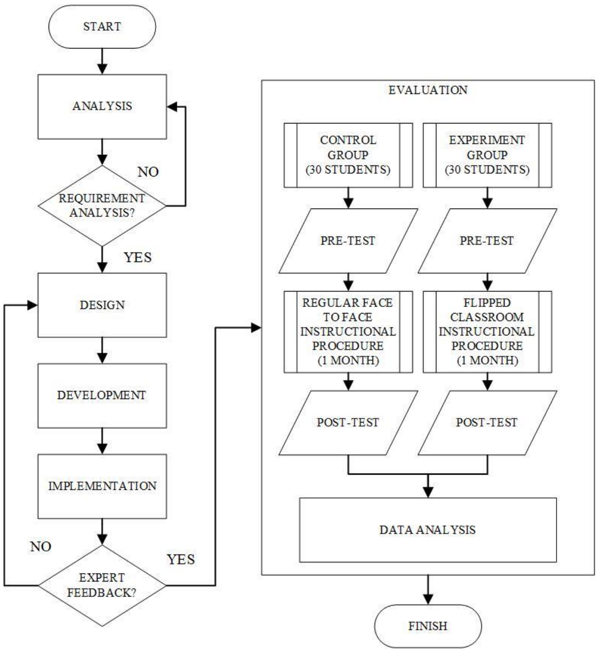

Figure 1. Research Process

Analysis is the stage of extracting information related to what students must master competencies and what the students' characteristics are so that the learning tools used in research can be right on target. The analysis results were compiled based on direct observation during the learning process in the classroom and interviews with information technology subjects at a public vocational high school in Malang, Indonesia. This stage is divided into needs analysis and performance analysis.

The design stage is the stage of designing the design of the learning procedure. The learning procedure is designed based on the dimensions of the development procedure, which is based on four aspects: the function, origin, source, and analysis scheme [55]. The model development procedure used in this study is of type F1-O1-S1-A1. F1 means that the designed procedure constructs knowledge of the conceptual learning design model, O1 means using a theoretical approach, S1 indicates that the source used comes from the literature, and A1 is intended that this model connects variables or all activities into the learning design.

Activities at the development stage are the preparation of learning tools in the form of teaching materials and evaluation assessments to be integrated into certain media to become final products ready to be presented to students. It begins with compiling lesson plans for experimental and control groups, compiling materials, and compiling evaluation questions. The lesson plan is prepared for 10th-grade Digital Simulation and Communication Subjects on designing pre-production stage documents in simulation and digital communication subjects. The lesson plan preparation follows the one-sheet format followed by vocational high school. The material for the control group is packaged in PowerPoint presentation slides, while the experimental group gets the material packaged in illustrative videos. Before being tested, all instruments undergo an expert's validation or appraisal process. This research involved three experts: one curriculum expert (learning models and approaches), one body of knowledge or subject matter expert, and one linguist expert.

Table 1. Developed FC Instructional Procedure Comparison Condition

Before Appraisal by Expert	After Appraisal by Expert
There are no provoking questions between delivering material that is asked to students to increase student curiosity.	In between delivering the material, the narrator asks provoking questions in the "Forms of visualization" and "Types of visualization" sections.
The delivery style is still too complicated and difficult to understand.	Change the editorial explanation to simple language in the "Characteristics of video presentation", "Types of video presentation", and "Stages of video creation" sections
There are no actual examples of documents submitted, for example, showing documents in the form of scripts, synopses and storyboards.	Insert real examples of script documents, synopsis and storyboards.

There is no explanation regarding what elements must be in the pre-production document so that students can prepare the document.	Explain the elements in the script document, write a synopsis, and how to make a storyboard.
Some parts of the audio are still leaking, so they need to be repaired so that the audio quality is more precise and better.	Replaced some leaked audio parts with more precise audio recordings.
It doesn't display summary text at the end of the video.	Displays summary text at the end of the video.

The implementation stage contains activities for applying FC instructional procedures with a constructivist approach to 30 10th-grade students acting as experiment groups (SIJA-1). In contrast, the control group is a comparison variable involving 30 10th-grade students (SIJA-2) who typically run learning scenarios through the lecture method through presentation slides media. Several references related to experimental research state that if the number of participants in each group is 15-30 people, then this number is sufficient for experimental research [56]. The end of the analysis process in this research is calculating the gain effect (g), where a data set of 30 data is sufficient to calculate the g score [57], [58].

There is a precondition for students: one day before the implementation of learning in the classroom, the teacher gives a pre-test. Experimental groups were preconditioned after the pre-test was continued by providing illustrative videos of the material shared by the teacher through the school's learning management system (LMS). At the time of the learning activity, the treatment between the control and the experiment group was different, adjusting to the procedure of the learning activity. At the end of the lesson, students are given a post-test.

The evaluation stage contains data processing activities of the results of testing procedures. The results of the compared data are the average of the grades, minimum values, and maximum values between the experimental and control groups. Furthermore, a normality test was carried out using Kolmogorov-Smirnov and a homogeneity test with Levene's test. Three conditions determine the subsequent calculation, namely: (1) An independent sample T-test with the same variance is used when the data is typically distributed and homogeneous; (2) An independent sample T-test with unequal variance is used if the data is distributed normally but not homogeneous; and (3) If one or all of the data distributions examined are generally not distributed and are homogeneous, then use the Mann-Whitney test. Furthermore, the gain index data was analyzed to find the effectiveness of learning procedures in improving student learning outcomes.

RESULT

The development research resulted in an FC instructional procedure that adapts the concept of constructivism. The aspect analyzed in the needs analysis is students' ability to master their characteristics. The results of the needs analysis are: (1) the educational background of previous students who have never received Information Technology (IT) subjects, (2) the need for students to master the application of concepts in a concrete form, (3) the character of students who tend to like to see demonstrations then directly practice rather than reading textbooks, (4) the scope of simulation and digital communication subject matter or lesson is comprehensive and dense, and (5) a reduction in the duration of face-to-face group hours in the classroom even though the competency standards that students must master remain the same. The aspect analyzed in performance analysis is the relevance of the problems faced with the proposed solution, namely developing learning procedures. The results of the performance analysis are (1) low interest in reading students learning material from textbooks, (2) weak teacher control over students to study independently at home from the two points above, and (3) supporting media in the form of learning videos are considered appropriate to be given because students can control the learning tempo according to their needs. Based on the analysis results, it can be concluded that the purpose of developing learning procedures in this study is to streamline the learning process in the classroom with limited time in the hope of increasing student learning outcomes.

The instructional procedure with the FC model is designed through a constructivist approach that maximizes student learning activity in constructing their understanding of knowledge to create meaningful learning experiences. The design stage produces a syntax of learning procedures that contain constructivism components. First, the perception stage, giving basic questions online through LMS the day before the learning schedule in the classroom. The goal is to see to what extent the student has initial knowledge. Second is the exploration stage, which is the excavation of information by students. Teachers will share animated videos of learning with students through LMS, and hopefully, students will listen to the explanation of the material before attending face-to-face group meetings. Animation video media is an addition to the learning process, not to be boring. Students can fully control the tempo of their learning because they can repeat, pause, or slow down the video as needed. The third is the restructuring stage, which deepens the concept through discussion in classroom learning activities. Fourth is the application stage, i.e., the development and application of concepts into the project. The goal is for students to gain a theoretical understanding and mastery of practical skills. Fifth is the review and evaluation stage, namely providing teacher feedback to students. The components of this learning procedure activity are then compiled into the lesson plan document. A comparison between the FC results from previous research studies and those successfully developed in this research is presented in Figure 2 and Figure 3.

The design of the compiled learning procedure obtained an average validation value from experts of 0.87, so it was categorized as very high. The control and experimental groups' lesson plan validity got an average of 0.91, which is very high. The material validation results obtained an average value of 0.88, which is categorized as very high. The average value of the validation of the evaluation question is 0.82, so it is classified as very high. The range of values for instrument validity criteria can be seen in Table 2.

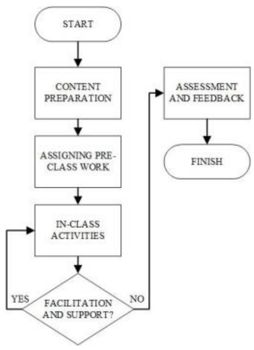

Figure 2. General Flipped Classroom Instructional Procedure

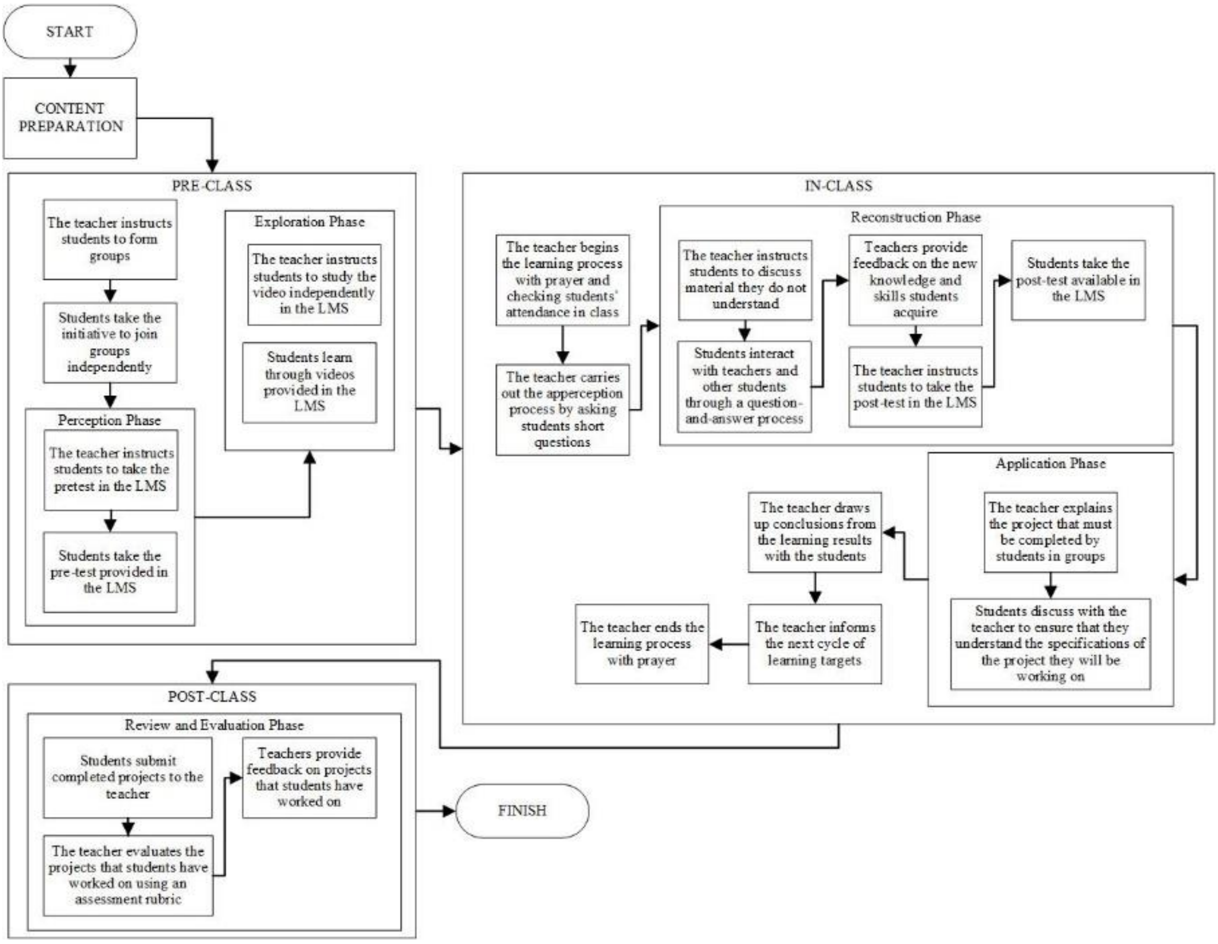

Figure 3. Developed Flipped Classroom Instructional Procedure with The Constructivist Approach

Table 2. Instrument Validity Criteria

Value Range	Criterion
0,81 – 1,00	Very High
0,61 – 0,80	High
0,41 – 0,60	Moderate
0,21 – 0,40	Low
0,00 – 0,20	Very Low

In the instrument validation process, there are several improvement notes from experts, followed up with instrument revision activities by researchers. Validation by experts is carried out for up to two cycles until there is no record of any more improvements from the experts, so the instrument can be said to be worth testing. The conclusion of the results of the validation of research instruments is that research instruments consisting of learning procedures, lesson plan documents, materials, and evaluation questions are included in the category of very high and worthy of being tested based on the experts' approval.

The pre-test results in the control group showed an average score of 40.00, with a minimum score of 20.00 and a maximum score of 60.00. The experimental group showed an average score of 49.67, with a minimum score of 30.00 and a maximum score of 70.00, as seen in Table 3.

Table 3. Descriptive Statistics of Pre-test Data

Group	N	Mean	Min.	Max.
Control	30	40.00	20.00	60.00
Experiment	30	49.67	30.00	70.00

The post-test results in the control group showed an average value of 64.30, with a minimum value of 50.00 and a maximum of 80.00. The experimental group showed an average value of 70.00 with a minimum value of 60 and a maximum value of 90.00, as seen in Table 4.

Table 4. Descriptive Statistics Post-test Data

Group	N	Mean	Min.	Max.
Control	30	64.30	50.00	80.00
Experiment	30	70.00	60.00	90.00

After obtaining descriptive statistical data from the pre-test and post-test of the control group and experiments, a normality test with Kolmogorov-Smirnov and a homogeneity test with Levene's test were carried out. The normality test of the control group pre-test results showed a p-value of 0.03, and the experimental group of 0.02 meant that the data was not normally distributed because the p-value was less than 0.05. The control group's post-test normality test showed a p-value of 0.007 and the experimental group's of 0.01. The pre-test data homogeneity test showed a p-value of 0.99 (more than 0.05), which means that the variance of both groups is the same or the data is homogeneous. The post-test data homogeneity test shows a p-value of 0.83 (more than 0.05), meaning that the data is homogeneous.

The conclusion that can be taken is that the pre-test and post-test results are abnormally distributed and homogeneous. Therefore, the calculation is continued with a non-parametric statistical test, namely the Mann-Whitney U test. The Mann-Whitney U test is carried out to prove the correctness of the hypothesis. The results of the Mann-Whitney test against the pre-test data obtained a value of 0.005 (less than 0.05), indicating that the difference between the control group and the experiment was significant, so H_0 was successfully rejected. Mann-Whitney's test results against post-test data yielded values of 0.001 (less than 0.05), so H_0 was successfully dismissed, indicating that the difference between the control group and the experiment was significant.

Normalized gain analysis calculated using Hake's formula aims to determine the effectiveness of the learning procedure. The normalized gain index analysis results in the experimental group (g = 0.50) were more significant than the control group (g = 0.41), which was grouped as moderate effectiveness criteria. The conclusion that can be taken from the analysis results is that the FC model's instructional procedure with a constructivist approach applied to the experimental group is more effective in improving the learning outcomes compared to the control group. The control group does not follow the FC instructional procedure with a constructivist approach.

DISCUSSION

Blended learning combines direct face-to-face and online instructional learning that integrates technology [4], [59]. Blended learning is best applied by combining the advantages of two learning systems (face-to-face and online) and eliminating the system's shortcomings. For example, discussion activities are more lively in classroom learning, while exploration activities are outside classroom learning, namely online. The blended learning system has a development, one of which is called a flipped classroom (FC). As the name implies, learning exploration activities were moved from the classroom to the home. The assignments and discussion activities were carried to dynamic and interactive in-group activities guided directly by the teacher. The teacher helps students apply concepts and is creatively involved in learning the subject matter.

Education management in Indonesia has experienced an accelerated introduction of terminology and concepts related to blended learning and FC since 2020 when there were restrictions on educational activities during the COVID-19 pandemic. The instructional process usually carried out face-to-face can now be limited to the number of students in the classroom and the reduction of classroom activity duration. This study developed the FC instructional procedure with a constructivist approach. The concept of constructivism consists of five stages, namely (1) the perception stage; (2) the exploration stage; (3) the restructuring stage; (4) the application and development stage; and (5) the review and evaluation stage.

The learning procedures developed in this research can bring the FC concept by taking advantage of online learning and face-to-face meetings in the classroom. The idea of constructivism that requires students to have basic knowledge before starting learning aligns with the FC model that provides material earlier for students to learn at home. The learning procedures developed also maximize the time of face-to-face meetings in the classroom for discussion activities between teachers and students and students with other students.

Previous research discussed the constructivist learning model. This hybrid learningstudy produced six main components, namely: (1) situations, which describe student learning goals; (2) groupings, i.e., grouping students to interact with each other; (3) bridges, which link previous knowledge with new ones; (4) questions, which allow students to ask questions to construct concept constructions; (5) exhibits, i.e., displaying learning outcomes; and (6) reflections, i.e., reflections on what has been learned. The gap in the study was that there was no time for self-study before students entered the classroom. One of the constructivist principles is that students prepare before learning begins by extracting initial knowledge of the material to be discussed.

The learning procedures developed in this study can accommodate students in exploring initial knowledge before starting learning. The teacher facilitates students by providing video illustrations of learning related to the lesson to be discussed in the group at the exploration stage. Students gain a basic understanding of the video being watched. Discussions will strengthen this basic understanding and questions, answers, or even practicums in the classroom with the teacher's guidance [60]

Based on the expert validation results of the FC instructional procedure with a constructivist approach, the researcher determined that this procedure met the evaluation criteria in the excellent category. The first problem that arises in the background is the low awareness of students in following the teacher's instructions for self-study at home. However, this research recommends FC instructional procedures for vocational high school students majoring in information technology because students can comply with and follow existing procedures. Researchers also suggest that vocational high schools majoring in information technology gradually start producing learning videos or looking for reference learning resources in video material. Students can learn independently at home with these videos because video media allows them to control video according to their respective learning.

The data analyzed in this study were students' learning outcomes in the control and experiment groups, with a research sample of 30 students. Researchers use a constructivist approach to apply FC instructional procedures to experimental groups, while control groups use face-to-face instructional procedures that are usually followed. The learning outcomes measured are cognitive learning outcomes through pre-test and post-test scores. After the control and experiment groups were treated, the results were obtained that the learning outcomes of the two groups of students showed differences. The effectiveness of FC model instructional procedures applied to experimental groups was calculated using Hake's formula. The gain value of the experimental group is higher than that of the control group. The FC instructional procedures with a constructivist approach are more effective in improving the students' learning than the traditional face-to-face instructional process.

A researcher who also developed an FC instructional process conducted a similar study [61]. The research uses the same research design, namely pre-test and post-test. The most striking difference is the constructivist concept researchers incorporate into the FC instructional process. Constructivist concepts will influence the design of student learning activities to build an understanding of students' concepts [62], [63]. The design of learning activities can indirectly affect student learning outcomes. The research found that the learning outcomes between the control and experimental groups differed. The conclusion that can be drawn from comparing such studies is that although both apply FC instructional model procedures with constructivism, they can provide more outstanding learning outcomes.

CONCLUSION

This study concludes that the research on the development of FC model instructional procedures produces outputs from the phases of instructional procedures that use a constructivist learning approach. This instructional procedure consists of (1) the perception stage, that is, asking students basic questions as assignments before the start of learning in the classroom; (2) the exploration stage, where students dig up information through learning videos that contain material to be discussed together during learning in the classroom; (3) the restructuring stage, namely the discussion and deepening of concepts with the teacher in the classroom; (4) the application stage, namely if the student already understands the concept, they can apply it to a project; (5) review and evaluation stage, which is to provide feedback on the results of evaluations, projects or tasks completed by students. The process of instructional procedures is developed concerning constructivist learning and is designed to allow students to build an understanding of their concepts. Descriptive statistical calculations and comparison of gain values between the experimental and control groups showed that the effectiveness of the FC instructional model procedure applied to the experimental group was higher than that of the control group. It can be concluded that the FC instructional model procedure effectively improves learning outcomes.

The advice that researchers can give for future research is related to the type of material used in the study, which needs to be varied to the kind of procedural material that contains practicum activities. The second suggestion is to be able to add experimental groups that use different variations of procedures so that they can be compared between one procedure option and another. Variations of this procedure can be distinguished based on the use of various media or differences in the time lag of teaching at the exploration stage.

REFERENCES

[1] S. Hrastinski, "What Do We Mean by Blended Learning?," *TechTrends*, vol. 63, no. 5, pp. 564–569, 2019, doi: 10.1007/s11528-019-00375-5.

[2] R. A. Rasheed, A. Kamsin, and N. A. Abdullah, "Challenges in the online component of blended learning: A systematic review," *Comput Educ*, vol. 144, 2020, doi: 10.1016/j.compedu.2019.103701.

[3] C. Müller and T. Mildenberger, "Facilitating flexible learning by replacing classroom time with an online learning environment: A systematic review of blended learning in higher education," *Educ Res Rev*, vol. 34, 2021, doi: 10.1016/j.edurev.2021.100394.

[4] B. Basori, S. Sajidan, M. Akhyar, and W. Wiranto, "Blended learning model towards vocational students' learning outcomes: A scoping review," *International Journal of Evaluation and Research in Education*, vol. 12, no. 1, pp. 205–215, 2023, doi: 10.11591/ijere.v12i1.22986.

[5] B. Anthony *et al.*, "Blended Learning Adoption and Implementation in Higher Education: A Theoretical and Systematic Review," *Technology, Knowledge and Learning*, vol. 27, no. 2, pp. 531–578, 2022, doi: 10.1007/s10758-020-09477-z.

[6] Z. Turan and B. Akdag-Cimen, "Flipped classroom in English language teaching: a systematic review," *Comput Assist Lang Learn*, vol. 33, no. 5–6, pp. 590–606, 2020, doi: 10.1080/09588221.2019.1584117.

[7] D. Zou, S. Luo, H. Xie, and G. J. Hwang, "A systematic review of research on flipped language classrooms: theoretical foundations, learning activities, tools, research topics and findings," *Comput Assist Lang Learn*, vol. 35, no. 8, pp. 1811–1837, 2022, doi: 10.1080/09588221.2020.1839502.

[8] L. J. Day, "A gross anatomy flipped classroom effects performance, retention, and higher-level thinking in lower performing students," *Anat Sci Educ*, vol. 11, no. 6, pp. 565–574, 2018, doi: 10.1002/ase.1772.

[9] F. J. Hinojo Lucena, I. A. Díaz, J. M. Romero Rodríguez, and J. A. Marín Marín, "Influence of the flipped classroom on academic performance. A systematic review," *Campus Virtuales*, vol. 8, no. 1, pp. 9–18, 2019,

[Online]. Available: https://api.elsevier.com/content/abstract/scopus_id/85068354793

[10] R. Martínez-Jiménez and M. C. Ruiz-Jiménez, “Improving students’ satisfaction and learning performance using flipped classroom,” *International Journal of Management Education*, vol. 18, no. 3, 2020, doi: 10.1016/j.ijme.2020.100422.

[11] Y. T. Lin, “Impacts of a flipped classroom with a smart learning diagnosis system on students’ learning performance, perception, and problem solving ability in a software engineering course,” *Comput Human Behav*, vol. 95, pp. 187–196, 2019, doi: 10.1016/j.chb.2018.11.036.

[12] R. Fisher, Á. Perényi, and N. Birdthistle, “The positive relationship between flipped and blended learning and student engagement, performance and satisfaction,” *Active Learning in Higher Education*, vol. 22, no. 2, pp. 97–113, 2021, doi: 10.1177/1469787418801702.

[13] H. Luo, T. Yang, J. Xue, and M. Zuo, “Impact of student agency on learning performance and learning experience in a flipped classroom,” *British Journal of Educational Technology*, vol. 50, no. 2, pp. 819–831, 2019, doi: 10.1111/bjet.12604.

[14] P. Strelan, A. Osborn, and E. Palmer, “The flipped classroom: A meta-analysis of effects on student performance across disciplines and education levels,” *Educ Res Rev*, vol. 30, 2020, doi: 10.1016/j.edurev.2020.100314.

[15] H. C. Lin and G. J. Hwang, “Research trends of flipped classroom studies for medical courses: a review of journal publications from 2008 to 2017 based on the technology-enhanced learning model,” *Interactive Learning Environments*, vol. 27, no. 8, pp. 1011–1027, 2019, doi: 10.1080/10494820.2018.1467462.

[16] J. Phillips and F. Wiesbauer, “The flipped classroom in medical education: A new standard in teaching,” *Trends in Anaesthesia and Critical Care*, vol. 42, pp. 4–8, Feb. 2022, doi: 10.1016/j.tacc.2022.01.001.

[17] G. Akçayır and M. Akçayır, “The flipped classroom: A review of its advantages and challenges,” *Comput Educ*, vol. 126, pp. 334–345, 2018, doi: 10.1016/j.compedu.2018.07.021.

[18] Z. Zainuddin and M. Attaran, “Malaysian students’ perceptions of flipped classroom: a case study,” *Innovations in Education and Teaching International*, vol. 53, no. 6, pp. 660–670, 2016, doi: 10.1080/14703297.2015.1102079.

[19] H. Haghighi, M. Jafarigohar, H. Khoshsima, and F. Vahdany, “Impact of flipped classroom on EFL learners’ appropriate use of refusal: achievement, participation, perception,” *Comput Assist Lang Learn*, vol. 32, no. 3, pp. 261–293, 2019, doi: 10.1080/09588221.2018.1504083.

[20] C. L. Koo, E. L. Demps, C. Farris, J. D. Bowman, L. Panahi, and P. Boyle, “Impact of flipped classroom design on student performance and perceptions in a pharmacotherapy course,” *Am J Pharm Educ*, vol. 80, no. 2, 2016, doi: 10.5688/ajpe80233.

[21] C. K. Lo, C. W. Lie, and K. F. Hew, “Applying ‘First Principles of Instruction’ as a design theory of the flipped classroom: Findings from a collective study of four secondary school subjects,” *Comput Educ*, vol. 118, pp. 150–165, 2018, doi: 10.1016/j.compedu.2017.12.003.

[22] Z. Zainuddin and S. H. Halili, “Flipped classroom research and trends from different fields of study,” *International Review of Research in Open and Distance Learning*, vol. 17, no. 3, pp. 313–340, 2016, doi: 10.19173/irrodl.v17i3.2274.

[23] D. Hurrell, “Conceptual Knowledge OR Procedural Knowledge or Conceptual Knowledge AND Procedural Knowledge: Why the Conjunction is Important to Teachers,” *Australian Journal of Teacher Education*, vol. 46, no. 2, pp. 57–71, 2021, doi: 10.14221/ajte.2021v46n2.4.

[24] T. Yi, X. Yang, Z. Pi, L. Huang, and J. Yang, “Teachers’ continuous vs. intermittent presence in procedural knowledge instructional videos,” *Innovations in Education and Teaching International*, vol. 56, no. 4, pp. 481–492, 2019, doi: 10.1080/14703297.2018.1470020.

[25] G. Young, “Knowledge How, Procedural Knowledge, and the Type-Token Action Clause,” *Acta Analytica*, vol. 34, no. 3, pp. 327–343, 2019, doi: 10.1007/s12136-018-0376-1.

[26] Y.-T. Chen, S. Liou, and S.-M. Chen, “Flipping the procedural knowledge learning – a case study of software learning,” *Interactive Learning Environments*, vol. 29, no. 3, pp. 428–441, Apr. 2021, doi: 10.1080/10494820.2019.1579231.

[27] B. H. Majeed, “The relationship between conceptual knowledge and procedural knowledge among students of the mathematics department at the faculty of education for pure sciences/IBn Al-Haitham, university of Baghdad,” *International Journal of Innovation, Creativity and Change*, vol. 12, no. 4, pp. 333–346, 2020,

Accessed: Jun. 27, 2023. [Online]. Available: https://www.ijicc.net/images/vol12/iss4/12439_Majeed_2020_E_R.pdf

[28] A. D. Herlambang, B. Budiman, and W. S. Wardhono, "Interactive Procedural Knowledge Learning Resources Development in The Context of Competency-Based Training Instructional Approach and Interactive Media Design Subjects for Information Technology Vocational High School," *Elinvo (Electronics, Informatics, and Vocational Education); Vol 7, No 1 (2022): Mei 2022DO - 10.21831/elinvo.v7i1.48215* , Aug. 2022, doi: https://doi.org/10.21831/elinvo.v7i1.48215.

[29] L. K. J. Baartman and E. De Bruijn, "Integrating knowledge, skills and attitudes: Conceptualising learning processes towards vocational competence," *Educational Research Review*, vol. 6, no. 2. pp. 125–134, 2011. doi: 10.1016/j.edurev.2011.03.001.

[30] H. Schaap, L. Baartman, and E. de Bruijn, "Students' Learning Processes during School-Based Learning and Workplace Learning in Vocational Education: A Review," *Vocations and Learning*, vol. 5, no. 2. pp. 99–117, 2012. doi: 10.1007/s12186-011-9069-2.

[31] Suharno, N. A. Pambudi, and B. Harjanto, "Vocational education in Indonesia: History, development, opportunities, and challenges," *Child Youth Serv Rev*, vol. 115, no. 2020, p. 105092, Aug. 2020, doi: 10.1016/j.childyouth.2020.105092.

[32] H. Morgan, K. Mclean, C. Chapman, J. Fitzgerald, A. Yousuf, and M. Hammoud, "The flipped classroom for medical students," *Clinical Teacher*, vol. 12, no. 3, pp. 155–160, 2015, doi: 10.1111/tct.12328.

[33] F. Chen, A. M. Lui, and S. M. Martinelli, "A systematic review of the effectiveness of flipped classrooms in medical education," *Med Educ*, vol. 51, no. 6, pp. 585–597, 2017, doi: 10.1111/medu.13272.

[34] C. J. Ramnanan and L. D. Pound, "Advances in medical education and practice: student perceptions of the flipped classroom," *Adv Med Educ Pract*, vol. 8, pp. 63–73, 2017, doi: 10.2147/AMEP.S109037.

[35] S. E. Street, K. O. Gilliland, C. McNeil, and K. Royal, "The Flipped Classroom Improved Medical Student Performance and Satisfaction in a Pre-clinical Physiology Course," *Med Sci Educ*, vol. 25, no. 1, pp. 35–43, 2015, doi: 10.1007/s40670-014-0092-4.

[36] K. S. Chen *et al.*, "Academic outcomes of flipped classroom learning: a meta-analysis," *Med Educ*, vol. 52, no. 9, pp. 910–924, 2018, doi: 10.1111/medu.13616.

[37] F. Tang *et al.*, "Comparison between flipped classroom and lecture-based classroom in ophthalmology clerkship," *Med Educ Online*, vol. 22, no. 1, 2017, doi: 10.1080/10872981.2017.1395679.

[38] K. F. Hew and C. K. Lo, "Flipped classroom improves student learning in health professions education: A meta-analysis," *BMC Med Educ*, vol. 18, no. 1, 2018, doi: 10.1186/s12909-018-1144-z.

[39] J. Moffett and A. C. Mill, "Evaluation of the flipped classroom approach in a veterinary professional skills course," *Adv Med Educ Pract*, vol. 5, pp. 415–425, 2014, doi: 10.2147/AMEP.S70160.

[40] L. P. Galway, K. K. Corbett, T. K. Takaro, K. Tairyan, and E. Frank, "A novel integration of online and flipped classroom instructional models in public health higher education," *BMC Med Educ*, vol. 14, no. 1, 2014, doi: 10.1186/1472-6920-14-181.

[41] J. Ferrer-Torregrosa, M. Á. Jiménez-Rodríguez, J. Torralba-Estelles, F. Garzón-Farinós, M. Pérez-Bermejo, and N. Fernández-Ehrling, "Distance learning ects and flipped classroom in the anatomy learning: Comparative study of the use of augmented reality, video and notes," *BMC Med Educ*, vol. 16, no. 1, 2016, doi: 10.1186/s12909-016-0757-3.

[42] D. Gong, H. H. Yang, and J. Cai, "Exploring the key influencing factors on college students' computational thinking skills through flipped-classroom instruction," *International Journal of Educational Technology in Higher Education*, vol. 17, no. 1, 2020, doi: 10.1186/s41239-020-00196-0.

[43] T. Long, J. Cummins, and M. Waugh, "Use of the flipped classroom instructional model in higher education: instructors' perspectives," *J Comput High Educ*, vol. 29, no. 2, pp. 179–200, 2017, doi: 10.1007/s12528-016-9119-8.

[44] B. McNally *et al.*, "Flipped classroom experiences: student preferences and flip strategy in a higher education context," *High Educ (Dordr)*, vol. 73, no. 2, pp. 281–298, 2017, doi: 10.1007/s10734-016-0014-z.

[45] R. Kay, T. MacDonald, and M. DiGiuseppe, "A comparison of lecture-based, active, and flipped classroom teaching approaches in higher education," *J Comput High Educ*, vol. 31, no. 3, pp. 449–471, 2019, doi: 10.1007/s12528-018-9197-x.

[46] T. Mahfud, I. Siswanto, D. S. Wijayanto, and P. F. Puspitasari, "Antecedent factors of vocational high school students' readiness for selecting careers: A case in Indonesia," *Cakrawala Pendidikan*, vol. 39, no. 3, pp.

633–644, 2020, doi: 10.21831/cp.v39i3.32310.

[47] Suryaman, A. Zaki, Suharyanto, and S. Winoto, "Tripartite Interconnection to Serve High Quality and Competitiveness of Vocational School Students in Industry," *Journal of Social Studies Education Research*, vol. 14, no. 2, pp. 75–96, 2023, [Online]. Available: https://api.elsevier.com/content/abstract/scopus_id/85163020652

[48] S. M. Dougherty and A. R. Lombardi, "From Vocational Education to Career Readiness: The Ongoing Work of Linking Education and the Labor Market," *Review of Research in Education*, vol. 40, no. 1, pp. 326–355, 2016, doi: 10.3102/0091732X16678602.

[49] B. Pandiya, V. Tewari, and C. K. Upadhyay, "An empirical assessment of antecedents able to attract the prospective talented workforce for information technology industry across borders," *European Journal of International Management*, vol. 19, no. 4, pp. 491–517, 2023, doi: 10.1504/EJIM.2023.129531.

[50] C. Ismaniati, A. Muhtadi, D. Y. Cobena, and P. L. Soeparno, "Effectiveness of Flipped Classroom on Students' Learning Outcome in Vocational High School: A Meta-Analysis," *International Journal of Instruction*, vol. 16, no. 1, pp. 589–604, 2023, doi: 10.29333/iji.2023.16133a.

[51] L. Cheng, A. D. Ritzhaupt, and P. Antonenko, "Effects of the flipped classroom instructional strategy on students' learning outcomes: a meta-analysis," *Educational Technology Research and Development*, vol. 67, no. 4, pp. 793–824, 2019, doi: 10.1007/s11423-018-9633-7.

[52] B. Ghirardini, *E-Learning Methodologies: A Guide for Designing and Developing E-Learning Courses. Rome: Federal Ministry of Food*. Rome: FAO, 2011.

[53] R. M. Branch, *Instructional design: The ADDIE approach*. New York: Springer, 2010. doi: 10.1007/978-0-387-09506-6.

[54] Y. Hanafi, N. M. Murtadho, A. Ikhsan, and T. N. Diyana, "Reinforcing public university student's worship education by developing and implementing mobile-learning management system in the ADDIE instructional design model," *International Journal of Interactive Mobile Technologies*, vol. 14, no. 2, pp. 215–241, 2020, doi: 10.3991/ijim.v14i02.11380.

[55] P. Johannesson and E. Perjons, *An Introduction to Design Science*, 2nd ed. Switzerland: Springer Nature Switzerland AG, 2021. doi: https://doi.org/10.1007/978-3-030-78132-3.

[56] J. R. Fraenkel, N. E. Wallen, and H. H. Hyun, *How to Design and Evaluate Research in Education*. New York: McGraw Hill LLC, 2022. Accessed: Jun. 27, 2023. [Online]. Available: https://www.mheducation.com/highered/product/how-design-evaluate-research-education-fraenkel-wallen/M9781259913839.html

[57] J. Pallant, *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS*. United Kingdom: Open University Press/McGraw-Hill, 2020.

[58] S. Caldwell, *Statistics Unplugged*, 4th ed. Belmont: Wadsworth,Cengage Learning, 2013.

[59] S. Dwijonagoro and S. Suparno, "Pranatacara learning: Modeling, mind mapping, e-learning, or hybrid learning?," *Cakrawala Pendidikan*, vol. 38, no. 1, pp. 156–173, 2019, doi: 10.21831/cp.v38i1.23034.

[60] C. K. Lo, "Grounding the flipped classroom approach in the foundations of educational technology," *Educational Technology Research and Development*, vol. 66, no. 3, pp. 793–811, 2018, doi: 10.1007/s11423-018-9578-x.

[61] X. Wei *et al.*, "Effect of the flipped classroom on the mathematics performance of middle school students," *Educational Technology Research and Development*, vol. 68, no. 3, pp. 1461–1484, 2020, doi: 10.1007/s11423-020-09752-x.

[62] Y. Li, H. H. Yang, and J. MacLeod, "Preferences toward the constructivist smart classroom learning environment: examining pre-service teachers' connectedness," *Interactive Learning Environments*, vol. 27, no. 3, pp. 349–362, 2019, doi: 10.1080/10494820.2018.1474232.

[63] M. Tam, "Constructivism, instructional design, and technology: Implications for transforming distance learning," *Educational Technology and Society*, vol. 3, no. 2, pp. 50–60, 2000, [Online]. Available: https://api.elsevier.com/content/abstract/scopus_id/1842815361