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Learning Models in Educational Game Interactions: A Review

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Abstract – *Educational games have now been used as innovative media and teaching strategies to achieve more effective learning and have an impact that tends to be very good in the learning process. However, it is important to know and systematically prove that the application of the learning model in the interaction of educational games is indeed feasible to be adopted and has an effect. This paper aims to present empirical evidence of the current situation regarding the application of learning models in the flow of educational game interactions. The method used is a systematic literature review by adopting three main stages, namely: 1) Planning; 2) Implementation; 3) Reporting. Then recommend the ten steps in the systematic literature review process along with the selection process through the test-retest approach. The initial search obtained 1,405,310 papers, then go through the selection stage. The selection process took place at stage B1 with the number of papers that successfully passed 198, at the B2 selection stage there were 102 papers, and we focus 75 papers that have passed a fairly rigorous screening and selection process on the quality assessment process for primary studies, used to answer research objectives and questions. We can confirm and conclude that 75 papers have applied the learning model in educational game interactions. The dominating domain is Education, the type of game that dominates is Educational Game, for the most dominating subjects are Programming, Student Learning Motivation as the most dominating impact, Experimental Design as a trial technique, the most widely used evaluation instruments are Questionnaires and Tests, a population that dominates between 79-2,645 people, and 8 papers to support learning in vocational education.*

Keywords *– Engineering education, Game design, Game interaction, Learning approach, Systematic literature review, Vocational education.*
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1. Introduction

Today the increase in learning by utilizing technology has been widely promoted, one solution is to recommend game-based learning or in this case, we call it educational games. Educational games have been used as innovative teaching strategies to achieve more effective learning. At a simple level, [1] defines educational games as learning facilitated by the use of games and the development of educational games is a form of innovation from interactive multimedia containing educational content.

In a broader sense, an effective educational game design must achieve a balance between the elements of fun in the game and the value of education. Educational games are the relationship between education and entertainment. The entertainment aspects of the game are a means to increase motivation and learning experience [2]. Computers are risk-free environments and are media that can provide direct feedback. That is what is considered by the application of educational games on computers will increase the motivation of players, because players can explore and experiment more freely [3]. According to [4] game characteristics can be applied in the learning process. Children will be motivated when they do several tasks in the game. They become curious to solve the challenge, without realizing they have done several learning processes. Games can motivate students to improve learning achievement better and can improve student understanding to be more meaningful. Thus, games can be used to increase motivation and effectiveness of learning, especially for students who experience difficulties or feel uninteresting in learning.

To meet the objectives and provide more support for the ability of educational games to enhance learning, researchers have proposed applying learning models in educational games. According to Joyce and Weil in [5] argues that the learning model is a plan or pattern that can be used to shape the curriculum (long-term learning plan), design learning materials, and guide learning in class or the other. The learning model can be used as a choice pattern which means that the teacher can choose the right and efficient learning model to achieve his educational goals. The types of learning models are 1) Direct Learning; 2) Group Learning; 3) Problem-Based Learning.

The learning model has the characteristics proposed by [5], namely as follows:

1. Based on educational theory and learning theory from certain experts. For example, the group research model was compiled by Thelen and based on Dewey's theory. This model is designed to train democratic participation in groups.
2. Having a specific educational mission or purpose, for example, an inductive thinking model designed to develop an inductive thinking process.
3. Can be used as a guide for improving teaching and learning activities in the classroom, for example, the Synectic model is designed to improve creativity in writing lessons.
4. Has parts of the model called the sequence of learning steps (syntax), the existence of reaction principles, social systems, and support systems. The four sections are practical guidelines if the teacher will implement a learning model.
5. Having effects as a result of applied learning models. These impacts include the impact of learning namely learning outcomes that can be measured, the impact of accompaniment, namely long-term learning outcomes.
6. Make teaching preparation (instructional design) with the learning model guidelines chosen.

Furthermore, according to Winataputra in [6] argues that the learning model is a conceptual framework that describes a systematic procedure in organizing learning experiences to achieve certain learning goals and serves as a guide for instructors and instructors in launching and implementing learning activities. According to [6] the types of learning models consist of:

1. The contextual learning model is a learning concept that encourages the teacher to connect the material taught with the real-world situation of students. This learning also encourages students to make connections between their knowledge and their application in their daily lives. Students' knowledge and skills are obtained from efforts to build new knowledge and skills when they learn.
2. A cooperative learning model is a learning approach that focuses on using small groups of students to work together in maximizing learning conditions to achieve learning goals.
3. The quantum learning model is a collection of theories or perspectives on cognitive psychology and neurological programming that have long existed.
4. The integrated learning model is learning that allows students both individually and groups actively seek, explore, and find concepts and principles holistically. This learning is a model that tries to combine several topics.
5. The problem-based learning model is learning that takes cognitive psychology as its theoretical support. The focus is not much on what students are doing but on what students think as long as they do it. The teacher functions himself as a guide and facilitator so students can learn to think and solve their problems.

Based on these statements, it can be concluded that the definition of educational games. In general, is a digital gaming device that is packaged in the context of education or something educational, which aims to motivate students in the learning process. Many studies have shown that game-based learning can overcome problems in education. In connection with the amount of research on educational games as an effort to overcome problems in the field of education especially for vocational education, in our study this is to obtain empirical evidence about the collaboration between educational games and learning models, where the educational game applies the syntax of the elements in the learning model, so far we haven't found a single paper that discusses the same thing. The contributions of this paper are: 1) Classifying and summarizing existing evidence about what learning models have been applied to educational games in domains, types, subjects, impacts, evaluation techniques, population size, and whether or not there is the application for vocational education; 2) Providing a quick reference for researchers interested in designing and implementing educational games that apply the syntax of the elements in the learning model; 3) Providing an evidence base for the implementation of educational games that apply the syntax of the elements in the learning model.

The structure of this paper is as follows: Section 1 contains an introduction which is the background of this research. Section 2 presents related work. In Section 3 the method used for a systematic literature review. Section 4 shows the results of the review. Section 5 offers a discussion of the results that have been obtained. Section 6 shows the main threats found in the validity of this study. Finally, Section 7 states conclusions and future work based on the findings that have been obtained.

2. Related Works

Systematic Literature Review (SLR) is a means of identifying, evaluating, and interpreting all available research, expressed relevant to certain research questions, or topic areas, or phenomena that are considered interesting to peel. Individual studies that contribute to a systematic review are called primary studies; a systematic review is a form of secondary study [7].

This SLR works in the field of educational games that apply the syntax of the elements of the learning model. Before trying this work, we conducted a preliminary study to identify secondary studies that were in the same scope. For that reason, we conduct automatic searches in electronic databases indexed by Scopus. This search was conducted in September 2018, using the search string "(Learning Model OR Learning Approach OR Learning Strategy) AND Educational Games AND (Systematic Literature Review OR Literature Review OR Research Review OR Systematic Overview OR Systematic Mapping OR Mapping Study OR Systematic Mapping Study OR Systematic Review of Research OR Qualitative Literature Review)."

When we do a search based on search strings, none of the secondary studies are significantly and precisely related

that can be identified. However, when we conducted the search we found several papers that discussed SLR within the scope of educational games, namely how to evaluate the educational game by [8] where their study examined the importance of how to evaluate educational games systematically to obtain strong evidence of its impact, for the initial sample of 21,291 papers from which 11 relevant papers have been identified, illustrating 7 approaches to systematically evaluating educational games, the conclusions from this study state that there is a need to identify more consistent and uniform patterns to systematically evaluate educational games, to obtain valid results that can be used as a basis for decisions on the application of educational games and/or continuous improvement for researchers who will evaluate educational games. The research we found later from [9] who conducted an empirical study of the role/activities of teachers regarding the use of games in education, data collection methods based on a SLR model, this work concludes that 21 papers state the role the teacher must be pedagogically active, the teacher's pedagogical activities become clear in various game-based learning processes: in planning, orientation, during play, and after the educational game playing session.

Finally, we find an SLR that discusses educational games for electrical power consumption material, by raising research questions, namely: 1) is there an educational game about electric power consumption?; 2) how was this educational game used?, 59 papers were found and reviewed, the results showed that there was a lack of papers discussing the use of educational games about the material being reviewed [10]. Although our work tends to have similarities with previous works, it is conducting an SLR on educational games but what is presented in our paper is very different because it focuses on the purpose of identifying and classifying what learning models have been used to be implemented in educational games. We have the opinion that in the area to identify and classify learning models in educational games, none of the studies conducted the same discussion. Then, in this study, we also analyzed other data that were necessary and related to the research questions in the learning model area in the educational game.

3. Research Methodology

To obtain a way of systematically evaluating educational games, we conducted SLR following a very popular procedure that is from [7]. SLR uses systematic and explicit methods to identify, evaluate, and interpret all relevant studies for clear research questions [7]. Figure 1 shows the method that contains the steps of the SLR process that we have adopted.

Figure 1. Method of systematic literature review

Based on Figure 1 visualize the steps carried out in this study, which consists of 10 pieces, namely: 1) Determine the research question; 2) Specify the online database specifically (journal); 3) Determine the engine/search term; 4) Perform screening (a process of selection, inclusion, and exclusion criteria); 5) Quality assessment; 6) Data collection; 7) Analyze data; 8) Presenting results; 9) Recommend a discussion of the findings; 10) Recommend conclusions and future work.

Furthermore, in this SLR review we also set three phases that must be carried out, namely: 1) Planning; 2) Implementation; 3) Reporting. In planning activities, review protocols are developed and how researchers must work and interact to make the decisions that have been decided. This protocol defines procedures for carrying out reviews and includes research questions, search and evaluation strategies, inclusion/exclusion criteria, quality assessment, forms of data collection, and analysis methods. The second phase focuses on executing the protocol as defined. Finally, the final phase aims to describe the final report. The main objective of our work is to identify useful information about the application of learning models in educational games. Therefore the purpose of this systematic literature review is:

1. Classify what learning models have been applied to the educational game.
2. Identifying and providing the evidence base for the implementation of educational games that apply the syntax of the elements in the learning model.
3. Collecting support data in the form of the domain, type, subject or material, impact or effect, evaluation technique or instrument, population or sample, and whether or not there is the application in the area of vocational education that has been used in the application of learning models in educational games.
4. In the following subsections, we describe the activities carried out in each phase of the SLR.

3.1. Determine of Research Questions

To achieve the objectives mentioned earlier, we have set eight research questions. These questions help to gather all the information needed. The research questions (RQ) submitted are as follows:

- RQ1: In what learning models research by applying educational games has been assessed?.
- RQ2: In what domains have studies on the application of educational game learning models been assessed?.

- RQ3: What types of educational games have been assessed in applying the learning model?.
- RQ4: In what subjects or research material has the educational game learning model been applied?.
- RQ5: How has the impact or effect been assessed on the application of the educational game learning model?.
- RQ6: What are the evaluation techniques or instruments used in research that apply learning models in educational games?.
- RQ7: What is the population size or sample involved in the assessment in the study by applying the educational game learning model?.
- RQ8: How much research by applying learning models in educational games for vocational education?.

The research questions have their respective objectives that can be observed. Our focus is on the RQ1 question, which model or approach or learning strategy has been applied in the educational game, the assessment points for RQ1 are very large because according to the purpose and title of this study. We want the emergence of RQ1 to provide opportunities great for finding, knowing, identifying, classifying, and proving that learning models can also be applied in educational games, such as for the syntax found in problem-posing learning models that are included in the flow of an educational game, there are many learning models available, but here we want to know in full that the diverse learning model is often applied manually in class and can be applied and adopted in digital educational games.

For questions on RQ2 to find out in what domains the research on the application of the educational game learning model has been assessed, we assume for the domain here is the area of educational games with learning models applied in what fields? Is that in the fields of education, health, social, cultural, or something else?. RQ3 aims to find out the type of educational game by applying the learning model that has been assessed, meaning here is that it tends to name the title is an educational game but when applied to research it is known that this type of game is serious games, game-based learning, augmented reality, virtual reality, puzzle games, web-based games, educational video games, and others even some that do not adhere to any type but purely educational games with learning models that they design themselves.

The RQ4 questions, namely any subject or material that applies the educational game learning model has been assessed, the application of indirect educational games in our opinion is a game that contains content that educates/provides learning experiences and immediately has relevance to the material/what subjects are contained in the content that educates them in a game, such as educational games on basic programming subjects, computer systems, and so on. RQ5 to find out the impact or effect of the use of educational games which have also implemented learning models, impacts or effects here consist of student learning activities, student learning outcomes, student motivation, student skills, critical thinking of students, etc., both before and after use educational games. For RQ6, we want to know in a nutshell how evaluation techniques and instruments used in research that apply learning models in educational games, evaluation techniques here we want to find out whether the research uses quasi-experimental or other methods and for what research instruments to use, what is the questionnaire or other. RQ7 which shows the population size or sample involved in the session on RQ6. Finally for RQ8 is a research question that knows and maps how many papers discuss the application of learning models in educational games to the area of vocational education, RQ8 is also related to the previous RQ7 because before determining sample size and the population they must know in advance where research will be applied.

3.2. Specify an Online Database

The scientific paper we are looking for is based on an online database of eight online journal databases indexed by Scopus, namely: Science Direct, Institute of Electrical and Electronics Engineers (IEEE) Xplore Digital Library, Digital Library Computing Machinery (ACM), Education Resources Information Center (ERIC), JSTOR, EBSCO, SpringerLink, and ProQuest. We use the Microsoft Office Excel application to store all information collected about the results of searches and the Mendeley application as a management tool for reference along with the format for citations. To do a review we adapted search strings for each database, for this search we limit only titles, abstracts, and keywords.

3.3. Determine of Search Terms

The purpose of the search term is to identify the main study. In-depth searches for papers were conducted to answer the research questions we submitted. First, we choose keywords for search. For this reason, general terms are used to ensure that most relevant research papers are included in this study. The main search terms are "Educational Games" and "Learning Models." The search string created using the steps described in [11] is as follows:

1. Lower the main terms of the question by identifying the main concepts.
2. Identify alternative spellings and synonyms for the main terms.
3. Check the keywords in the relevant papers that we already have.
4. Use Boolean OR to add alternative spelling and synonyms.
5. Use Boolean AND to connect the main terms.

We did some initial searches to test and match the search strings, the last search string consists of the following Boolean expressions "(A1 OR A2 OR A3 OR A4) AND (A1 OR A2 OR A3 OR A4 AND (B1 OR B2 OR B3 OR B4)) AND (C1 OR C2 OR C3) AND D1 AND (E1 OR E2 OR E3)," where the search expression is presented in Table 1.

Table 1. Search terms to identify related secondary studies

Id		Keywords
A	1	Educational Games
	2	Learning Games
	3	Learning Media

	4	Educational Media
B	1	Learning Model
	2	Learning Approach
	3	Learning Scenario
	4	Learning Strategics
C	1	Subjects
	2	Topic
	3	Material
D	1	Evaluation
E	1	Impact
	2	Effect
	3	Influence

3.4. Filtering (Selecting, Inclusion, and Exclusion Criteria)

The filtering process is a stage to find papers that are feasible to be reviewed in this study. For the filtering process shown in Figure 2.

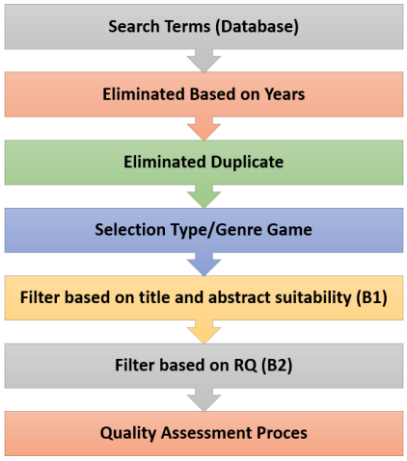

Figure 2. Filtering process

For the selection process, the study is conducted through a test-retest approach, and it is achieved in the following two phases:

1. Phase 1 (B1), papers found during the search process are evaluated according to their analysis of titles and abstracts. The titles and abstracts of each paper were reviewed based on inclusion and exclusion criteria. In this phase, we release an irrelevant publication. During this phase of the selection process, the papers found are classified as selected papers or nonelected papers.
2. Phase 2 (B2), phase 1 has been ascertained that it has been skipped and the selected paper will be directed to Phase 2 where this phase conducts a more thorough review which includes reading conclusions or even full text. This phase is done to ensure that the paper in question can certainly contain information that is relevant to the research.

The systematic review protocol chosen explicitly defines inclusion and exclusion criteria as follows:

1. Inclusion criteria
   - Research from 2014-2018.
   - Papers explain educational games and or learning games.
   - International publications (journals/proceedings) indexed by Scopus.
   - Includes one of the specified RQs.
2. Exclusion criteria
   - Papers whose main purpose is not for educational games and or learning games.
   - Does not include one of the specified RQ.
   - Paper is not from international publications (journals/proceedings) indexed by Scopus.
   - Paper will be excluded if it is only abstract (clear abstract context) but the full text is not available.
   - Papers not written in English will be excluded.
   - Duplicate paper (the same paper is taken from a different database).
   - Duplicate reports from the same study (when several reports from a study are in different databases, then a short version and the full version are found).

The assessment procedure in Phase 2 (B2) is using the values 0 and 1, the total value if fulfilled is all 8 because it adjusts from RQ. The minimum value of B2 is 4 which can be included at the next stage.

3.5. Quality Assessment

Each quality must be evaluated along with the publication data extraction process that is also carried out. Questionnaires, which must be filled in for each paper entered, are described as quality instruments. The assessment questionnaire consists of eight quality assessment questions and is divided into two parts. The first section has questions to identify the quality of papers on the main topics of this review (QA1); the question from the second part aims to identify the quality of the information provided by this paper, to determine the relevance of the papers in the SLR (QA2-QA8). The eight questions of quality assessment (QA) used are as follows:

1. QA1. Does this paper show the application of learning models in educational games and at the same time to answer RQ1?.
2. QA2. Does this paper show information about the domain of the application of learning models in educational games and at the same time make it possible to answer RQ2?.
3. QA3. Does this paper show information about the types of games from the application of learning models in educational games and at the same time make it possible to answer RQ3?.
4. QA4. Does this paper show information about subjects or material from the application of learning models in educational games and at the same time make it possible to answer RQ4?.
5. QA5. Does this paper show information about the impact or effect of the application of learning models in

educational games and at the same time make it possible to answer RQ5?.
6. QA6. Does this paper show information about evaluation techniques or instruments used in the application of learning models in educational games and at the same time make it possible to answer RQ6?.
7. QA7. Does this paper show information about the population size or sample involved in the application of learning models in educational games and at the same time make it possible to answer RQ7?.
8. QA8. Does this paper show information about the application of learning models in educational games for vocational education and at the same time make it possible to answer RQ8?.

Each question will be answered YES (Y) or NO (N), each question we give a score as follows:

1. QA1: Y, the inclusion criteria are explicitly defined in this study, that is, this paper presents information about the application of related learning models or synonyms, then explains how the application of syntax/learning model elements in educational games, and presents a game interface display education that has implemented a learning model (the paper can answer RQ1). N, the inclusion criteria are not explicitly defined and cannot be easily concluded.
2. QA2: Y, the publication provides information about the domain of the application of learning models in educational games (papers can answer RQ2). N, publications do not show the information needed.
3. QA3: Y, this paper presents information about the types of games applied to learning models in educational game (papers can answer RQ3). N, publications do not present any information about the type of game.
4. QA4: Y, this publication presents information about subjects or material that are used as elements of learning content in the application of learning models in educational games, allowing this paper not to provide information about subjects or material, but researchers can review the publication so that it can be concluded (papers can answer RQ4). N, papers cannot provide information about subjects or material both implicitly and explicitly.
5. QA5: Y, found papers can provide information about the impact or effect of the application of learning models in educational games (papers can answer RQ5). N, papers cannot provide information about impact or effect.
6. QA6: Y, this paper provides information about evaluation techniques or instruments used in the application of learning models in educational games (papers can answer RQ6). N, papers cannot provide the expected information.
7. QA7: Y, the paper found presents information about the population size or sample involved in the application of learning models in educational games (the paper can answer RQ7). N, the paper does not present the information needed.
8. QA8: Y, found papers can provide information about the application of learning models in educational games to vocational education, papers may not provide information for vocational education but also display applications to other formal/non-formal education, in this case, we continue to map, but mainly in vocational education (papers can answer RQ8). N, the publication found no information needed.

For the assessment procedure of this QA, we use Boolean values 0 and 1, where the value 1 for the answer Y (Yes) and the value 0 for the answer N (No), then from each paper will get the value. We set a paper that has the final value ≥ 5 is passed in each stage of the selection and only papers that fulfill QA1 (at the same time answer RQ1) can be passed at the last stage of selection because QA1 and RQ1 are guidelines, titles, and main answers from our review.

3.6. Data Collection

In taking this data is to take papers that have passed the screening and the last selection, namely the process of quality assessment, where the papers that pass will be the final review and the main for this study, there is a minimum score of 5 and at this stage more stringent, all papers which do not meet RQ1 about the learning model, it will be aborted. From each paper, we extract some general data on the electronic database where the research was taken and the date of collection, title, author, date, and place of publication, abstract, language, and whether the full text is available.

Besides, more specific data needed to achieve our objectives are collected such as a) research objectives; b) answers to the research questions provided by this study; c) the results of applying quality assessments. We collect data included in this study and then review this process to ensure that the data obtained is appropriate. To ensure that the data requirements are fully met and the data obtained is accurate, the paper is fully read in this phase. All collected data is stored in a spreadsheet, ensuring that all information related to research is stored in one location. Also, this allows us to easily compare and analyze the data extracted during the synthesis process.

3.7. Data Analysis

Data from selected papers are classified according to the following criteria:

1. Models or approaches or learning strategies that apply educational games (answer RQ1).
2. The domain in the application of learning models in educational games (answer RQ2).
3. The type of game applied to the learning models in educational games (answer RQ3).
4. Subjects or material by applying learning models in educational games (answer RQ4).
5. Impact or effect of the application of learning models in educational games (answer RQ5).
6. Evaluation techniques or instruments used in research that apply the learning model in educational game (answer RQ6).

7. Population size or sample involved in the assessment in the study of the application of the learning models in educational games (answer RQ7).
8. The number of studies that have implemented learning models in educational games for vocational education (answer RQ8).

4. Results

The SLR process was completed in five months. During this period, we defined the SLR protocol, identified and selected the main studies, carried out data extraction and synthesis processes, and finally reported the results of our research. All SLR processes are carried out by four researchers with the division of tasks, namely: The first and second researchers of this paper carry out the full SLR process; The third researcher reviews the first work and ensures the methodology is well done; The fourth researcher ensures the methodology has been done well, checks the format of writing, and completeness of this paper. The results section focuses on the search results analyzed and the quality evaluation results displayed. In the following subsections, the results of the SLR process.

4.1. Search Results

Search papers related to the application of learning models in educational games have been carried out from September 2018-October 2018. The first search results in all electronic databases based on search strings produced 1,405,310 papers, the process is shown in Figure 4 and for database-based results presented in Table 2 and visualization of the diagram in Figure 3.

Table 2. First search results based on database mapping

Database	Number of Paper Found
ACM Digital Library	3,158
EBSCO	25
ERIC	48,247
IEEE Xplore Digital Library	90
JSTOR	621,901
ProQuest	172,026
Science Direct	403,497
Springer Link	156,366
Total	1,405,310

Based on Table 2 it can be explained that for this first search result, most papers were found on JSTOR's database of 621,901 papers and the lowest occupied by EBSCO's database, only 25 identified search engines. Next, we reassure by eliminating year-based papers, where we set papers from the 2014-2018 range (see section 3 and 3.4 inclusion criteria), from the results of this elimination 633 appropriate papers are shown in Table 3. Database mapping that has gone through stages of elimination by year is shown in Figure 3.

Table 3. Search results by the year

Year	Number of papers
2014	96
2015	121
2016	134
2017	165
2018	117
Total Overall Papers	633

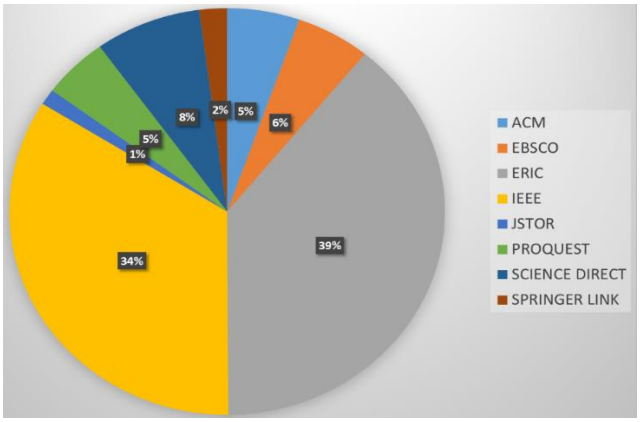

Figure 3. Database mapping results based on the year elimination

We aim to only take papers from 2014-2018 to find renewable papers and become a benchmark for current research. From Figure 3, it can be seen that in the database mapping, the most found papers came from the ERIC database, there were 247 papers with a percentage of 39%, followed by databases derived from IEEE Xplore Digital Library totaling 215 papers with a percentage of 34%, and the least found in the JSTOR database is only 8 papers with a percentage of 1%. Then we have to keep reassuring whether the papers that have been eliminated based on the year have duplicated elements, so we do elimination again based on duplicated indications, duplicated here the meaning is papers that tend to be published in database A and also published in database B or the short version is published in database A and the full version in database B, or also the title is different in different databases but the contents of all papers are indicated the same, based on this we eliminated duplicates, 167 papers indicated duplication and we stated abortions, which left 466 papers to be submitted in the next process, namely the selection stage for the type/genre of the educational game shown in Table 4, at the type/genre selection stage of this educational game the maximum is what we think the game is indirectly or directly known that that is an educational game not outside the area (purely not an educational game), which based on the type/genre of educational games finally left 202 papers that will enter the stages of selection.

Table 4. Search results by type/genre

Type/Genre	Number of Papers
Educational Games (Serious Game, Game Based Learning, Video Based Learning, Digital Based Learning, Learning Games, Web Based Learning, Mobile Learning, Augmented Reality, Virtual Reality, E-Learning, Interactive Learning)	202
Serious Games	10
Role Play Games	15
Video Games	25
Mobile Games	58
Online Games	52
Real-Time Strategy	34
Computer Games	20
Others	50
Total Overall Papers	466

4.2. Selection Results

The selection process starts with 202 papers. This process has two steps. In the first step, we analyzed the titles and abstracts of each paper following the inclusion and exclusion criteria. After this first review, the list of publications was reduced to 198 papers. Then we conduct a second review of the selection process, where the full text of our paper is analyzed. As a result of this second review, we excluded 96 additional papers from our list, then obtained a total of 102 papers. Furthermore, to answer our study that required RQ1 to be fulfilled from 102 papers, 75 papers were obtained which were the main studies we should review forget an answer from all the RQs submitted, for the stages of the results of the selection process are presented in Figure 4.

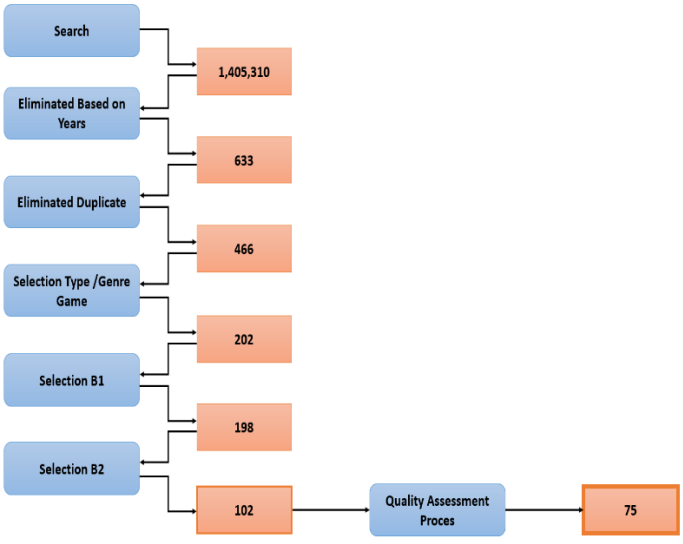

Figure 4. Results of the selection process

The SLR process starts from September 2018 to January 2019 with the development of protocols and various activities carried out in detail (See Appendix 1).

4.3. Primary Study Quality Assessment

The assessment of the quality of this primary study was a further step from the B2 selection stage (see Figure 4), finally, in this step, we assessed 102 papers. This step allows us to do the next step in the selection process that is selecting based on detailed quality criteria. Eight quality questions were assessed for each study selected according to the criteria set out in the quality questionnaire. For the coverage of the results of each QA from 102 papers shown in Figure 5.

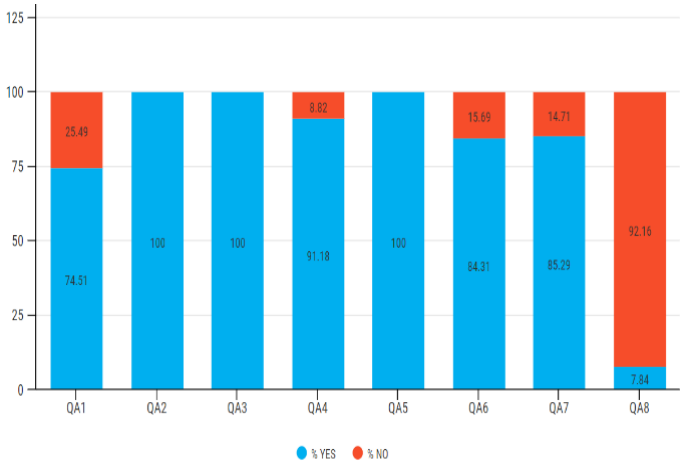

Figure 5. Results of quality assessment on each question

Based on Figure 5, it can be concluded that at each QA the results of the answers are very varied, namely for QA2, QA3, and QA5, have the highest answer value Y with a percentage of 100% with a total of 102 papers and the answer value N with 0% without there is a paper. For QA1, Y results are obtained with the percentage of 74.51% with the number of papers as much as 76 and the value for answer N with the percentage of 25.49% with 26 papers. A total of 93 papers have Y answers with a percentage of 91.18% and 9 papers with a percentage of 8.82% for N answers for QA4. Then for QA6 with the answer value Y obtained 86 papers with a percentage of 84.31% and the answer value N percentage 15.69% with papers totaling 16. For QA7 for the value of Y answers obtained as many as 87 papers with a percentage of 85.29% and answers to N percentage of 14.71% with the number of papers 15 pieces. Finally, for QA8, the smallest Y answer value is 8 papers with a percentage of 7.84% and the highest N answer value is 94 papers with a percentage of 92.16%.

For QA1, it is our main study, but in the previous selection stage we still provide concessions first, because the values in the other QA are more, then for QA2, QA3, and QA5 the highest Y answer is due to our main study focusing on the search for educational games on domains, subjects or material, and impacts or effects. Then follow with QA4, QA6, and QA7 as additional and supporting data. Finally, for QA8 we only prove whether or not there is the application of educational games in the area of vocational education. For mapping the overall value of 102 papers for the results of the quality assessment shown in Figure 6.

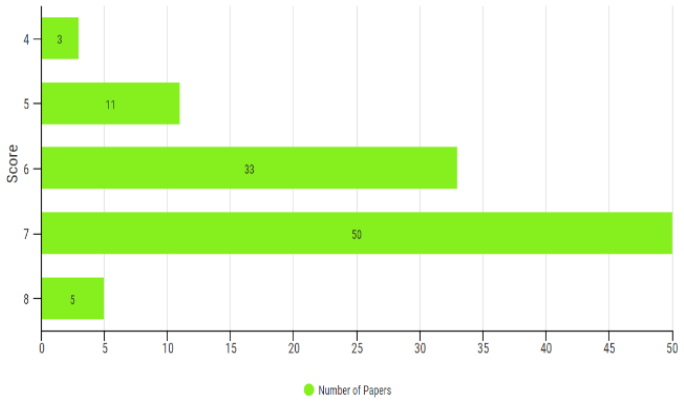

Figure 6. Total score for the assessment of paper quality

Next, we decided to treat these 102 papers more strictly for the quality assessment stage by reducing the amount of data with a score of 0 contained in each QA, with the following criteria: 1) Papers with a final score <5 we will issue from review because the paper is not relevant to the research question or lack of information; 2) Several papers exceed the value of 5 but RQ1 is not answered in full, so our decision also issues the paper; 3) If a paper with RQ1 is answered but the total final score <5 decisions we also issue the paper. The decision we made is based on our consideration of a review of 102 papers. Finally, from a rigorous quality assessment process, 27 papers are issued because they do not meet the specified criteria and can produce as many as 75 papers that take part in our main synthesis process shown in Table 5.

Table 5. Final results of papers for primary studies

Primary Study	*Quality Score Final Score*	*Number of Papers*
([12]; [13]; [14]; [15]; [16])	8	5
([17]; [18]; [19]; [20]; [21]; [22]; [23]; [24]; [25]; [26]; [27]; [28]; [29]; [30]; [31]; [32]; [33]; [34]; [35]; [36]; [37]; [38]; [39]; [40]; [41]; [42]; [43]; [44]; [45]; [46]; [47]; [48]; [49]; [50]; [51]; [52]; [53]; [54]; [55]; [56]; [57]; [58]; [59]; [60]; [61]; [62]; [63]; [64]; [65]; [66])	7	50
([67]; [68]; [69]; [70]; [71]; [72]; [73]; [74]; [75]; [76]; [77]; [78]; [79]; [80])	6	14
([81]; [82]; [83]; [84]; [85]; [86])	5	6
Total Overall Papers		75

Based on the results of the data from Table 5 that the highest quality rating score of 8 is occupied by 5 papers which in our opinion provide the information we need from this study, then the scores of the most papers are at the value of 7 with 50 papers. For a score of 6 with 14 papers and a score of 5 with 6 papers. Of the 70 papers that did not get a score of 8, the average paper did not have the opportunity to score 1 on the Y answer for QA8 and to answer RQ8.

5. Discussion

5.1. RQ1: In what learning models research by applying educational games has been as-sessed?

To answer this question we analyze information about any model or approach or learning strategy that has implemented an educational game. Based on our previous rules that RQ1 for all papers that have passed B2 must fulfill. So of the 75 papers that we conducted the study, with a percentage of 100% or all papers automatically applied the learning model in educational games. Detailed mapping results can be seen in Appendix 2.

The mapping results from Appendix 2 show that for the 67 types of learning models, and the most dominating ones are the Problem Based Learning model with a total of 6 papers, ranking in the top 6 is shown in Figure 7. Application of the Problem Based Model Learning in-game education has been done by ([17]; [83]; [74]; [18]; [65]; [19]). In this RQ1, learning models that are generally known in the world of education are Problem Based Learning; Problem-Posing; Problem Solving; Team Games Tournament; Student-Centered Learning; Collaborative Learning; Project-Based Learning; Computational Thinking Approach; Constructivist Approach; Cooperative Learning; Pedagogical Teaching and Learning; Pedagogical Approach; Game-Based Learning; E-Learning; Thematic Methods; Classroom Approach; Learning Approach; Active Learning Strategic; Learning Analytics (LA); Playing Learning; Problem-Centered Learning.

In this SLR found that some learning models that we consider new or a combination of learning models, so the name of the learning model feels strange, from the results of combining these learning models finally applied to educational games. The ranking of the application of learning models in educational games is shown in Figure 7.

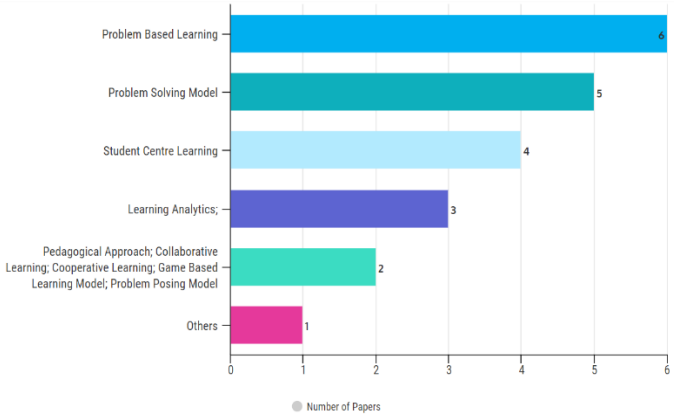

Figure 7. Ranking of learning models in educational games

The next finding is the database for providers of online journals or proceedings that have answered this RQ1, the most found papers in the ERIC database are 23 papers, then from the IEEE Xplore Digital Library database there are 21 papers, for the 17 Science Direct database papers, in the EBSCO database found 8 papers, for the ACM Digital Library database only 3 papers, in the ProQuest database there were

2 papers, only 1 paper in the SpringerLink database, and none of the papers passed from the JSTOR database.

We try to highlight examples of the application of learning models in educational games, first by using the Problem Based Learning learning model because it ranks first with the most papers, conducted by [17], where applying problem-based learning to programming subjects for educational games, where the problem is extracted in the real environment, then from the excavation, the problem is made into a program that ultimately affects the performance of the projects they produce, the educational game developed in the form of scratches. Then also the application of the Problem Based Learning model in the educational game about historical subjects from [83], where the model was named UCHALLENGE. The UCHALLENGE model interface, in summary, consists of modules for tutors used by teachers and modules for students, where each module has different access rights and management. The tutor module initially presents a learning management interface, where teachers can access and manage games, content, problems, and challenges that will be used. The student module displays the main page interface, where the available games are displayed, then students interact.

Problem-based learning itself as a means to stimulate information and concepts of learning through teaching with both methods of problem approach and developing the right attitude towards problem-solving. Problem Based Learning was first discovered by Finkle and Torp as one of the curricula and learning development systems that develop both problem-solving strategies and basic knowledge and skills by exposing students to ill-structured problems as a reflection of real problems to be solved properly (Savery & Duffy, 1995, in [87]). In [83] according to Barrows (1980) as for the short syntax of this Problem Based Learning model is Phase 1: Student orientation to the problem; Phase 2: Organize students to learn; Phase 3: Guiding individual and group investigations; Phase 4: Develop and present work; Phase 5: Analyze and evaluate the problem-solving process.

Second, we highlight the model that is ranked second with a total of 5 papers, namely the application of the Problem Solving learning model conducted by [48] that is a problem-solving model implemented to LariJava which is a web application based educational game that focuses on learning basic programming concepts. LariJava uses Java as its main programming language. This application provides examples and exercises for students to answer in the form of methods. The answer is checked with solutions and test cases of truth tables. The problem-solving model is a pedagogical methodology in which learning is fostered by challenges students must investigate to find solutions, or in other words, problem-solving activities begin with confrontation and end when answers have been obtained by the conditions of the problem.

Talking about the Problem Solving model can not be separated from the main character namely George Polya. In [88] defines that Problem Solving learning model as "the search for some appropriate actions to achieve goals that are clearly understood, but not immediately achieved. Where there are no difficulties, there are no problems." Then in solving a problem four steps must be done, namely: 1) Understanding the problem; 2) Planning for settlement; 3) Resolve problems according to plan; 4) Check again on all steps that have been done. The emergence of Problem Solving learning theory is based on constructivism theory which has the principle that students must build their knowledge so that their learning is meaningful.

According to [89] suggest the stages or syntax of operational strategies in the application of Problem Solving learning models, namely as follows: 1) I can: the stage of generating motivation and building/fostering student confidence; 2) Define: makes a list of known and unknown things, using graphic images to clarify the problem; 3) Explore: stimulates students to ask questions and guide to analyze the dimensions of the problems faced; 4) Plan: develop a logical way of thinking students to analyze problems and use a flowchart to describe the problems faced; 5) Do it: guiding students systematically to estimate possible answers to solve problems; 6) Check: guiding students to check the answers made, there may be some mistakes made; 7) Generalize: guiding students to ask questions.

The third rank with 4 papers highlighted the application of the Student-Centered Learning model conducted by [55] which is developing an educational-based digital game called CPGame to simulate compilers working with situations in everyday life in learning C programming languages, in its application, it is not specifically mentioned that in this study applying Student-Centered Learning models, but from the discussion that implicitly students are required to be active in learning, especially in the use of the CPGame application itself in the digital education game environment, the interesting thing for us is that of the 75 papers that we made as to the main study, implicitly it applies this Student-Centered Learning model.

Student-Centered Learning has been defined as the simplest as a learning approach where students choose not only what will be learned but also how and why the topic might be of interest to them [90]. In other words, the learning environment has basically the responsibilities and activities of students, in contrast to the emphasis on instructor control and the scope of academic content found in many conventional teaching, didactic teaching [91]. In addition, students find the learning process more meaningful when topics are relevant to their lives, needs, and interests, and when they are actively involved in creating, understanding, and connecting to knowledge [92].

The fourth rank is the application of learning models with Learning Analytics (LA) conducted by [67] who developed Learning Analytics with educational games whereas a basis to highlight the importance of modeling student personalities to provide personalized computer-based learning. Specifically, questionnaires are the most widely used method to model personality with a time that tends to belong and not motivating. This makes students do

not want to take it. Therefore, LA to implicitly model the personality of learners based on their footsteps generated during the playing process while in the learning process. LA is rooted in data science, artificial intelligence, and practice system recommendations, online marketing, and business intelligence.

LA is defined as the use of intelligent data, data produced by students, and analytical models to find information and social connections and to predict and advise on learning. LA is also considered as a measurement, collection, analysis, and reporting of data about students and their context, for understanding and optimizing learning and the environment in which it occurs. The five potential LA objectives are: 1) Providing feedback to students about their learning progress compared to their colleagues; 2) Can identify students at risk; 3) Help the instructor to plan interventions if needed; 4) Improve the course designed; 5) Support decision making when it comes to administrative tasks.

Our fifth rating is interested in highlighting the application of the Problem-Posing learning model, which has been done by [47] which proposes a scaffolding system in a learning environment by using the Problem-Posing learning model, this educational game system called Monsakun, aimed at increasing student awareness about the structure of arithmetic word problems. The proposed system can detect learners' congestion in real-time while creating problems and adaptively providing personalized tasks based on the bottlenecks that have been found. This aims to support students in overcoming congestion and get better knowledge about the structure of problems.

Initially, this Monsakun system was developed by [93] which was delivered at the beginning of his research experiment in the development of the Monsakun system, which concluded that elementary school students could continually come up with ideas to create problems, usability Monsakun system in the learning process, and can improve problem-solving skills for students who have low performance. In its development, the Monsakun system continues to grow very dynamically and experiences increased performance, this was stated in a study conducted by [47] which makes the Monsakun system as a means to conduct analysis and evaluation of student attitudes, student mindsets, and even the system can understand what students think.

Problem-posing is a learning model that requires students to compose their questions or break a question into simpler questions that refer to the resolution of the question. In mathematics learning, Problem-posing occupies a strategic position. Students must master the material and the sequence of problem-solving in detail. This will be achieved if students enrich their knowledge not only from the teacher but also need to learn independently. Posing problems are said to be the most important core in the discipline of mathematics. In [94] wrote that "Problem-posing is important in mathematics and like mathematical thinking." Then, explain that the submission of independent questions can be applied in 3 forms of cognitive mathematical activity as follows:

1. Pre Solution Posing, that is if a student makes a question from the situation that is held. So students are expected to be able to make questions related to previously made statements.
2. Within Solution Posing, which is if a student can reformulate the question into a new sub-question in the order of completion as previously completed. So, students are expected to be able to make new sub-questions from a question.
3. Post Solution Posing, that is if a student modifies the purpose or condition of the problem that has been completed to make a new question that is similar.

The syntax of applying Problem-Posing learning models according to [94] is as follows: 1) The teacher explains the subject matter to the students. The use of props to clarify concepts is strongly recommended; 2) The teacher gives enough practice questions; 3) Students are asked to submit 1 or 2 challenging questions, and the students concerned must be able to solve them. This task can also be carried out in groups; 4) At the next meeting, randomly, the teacher tells the students to present the findings of the findings in front of the class. In this case, the teacher can determine students selectively based on the weight of the questions posed by students; 5) The teacher gives home assignments individually. The steps in implementing the Problem-Posing learning model are as follows: 1) Opening learning activities; 2) Delivering learning objectives; 3) Delivering subject matter; 4) Give examples of solving problems; 5) allow asking questions; 6) allow students to make questions of the conditions given, exchange and discuss them; 7) Welcome students to present questions that have been formed; 8) Provide other conditions and provide opportunities for students to make as many questions as possible; 9) Invite students to exchange questions with other students and discuss them; 10) Directing students to conclude; 11) Make a summary based on student conclusions; 12) Close the lesson.

In the study of [96], the application of Problem-Posing to the Monsakun system can be described as a series of the composition of sentence cards in three available card slots. Students can submit problems by arranging sentences given and Monsakun require that students continue to cause problems until they can cause problems to meet the requirements. As a result, students make many compositions of sentence cards in three available card slots.

Finally for the sixth rank with the least number of papers, of which 75 papers each have only 1 paper, we are interested in highlighting the combination of learning models, namely Two-Tier Test-Based Learning System, Conventional Learning, and Technology Enhanced-Learning Approach conducted by [61] were proposed a Two-Tier Test-Based Learning System to improve student learning outcomes in computer programming subjects, then take a conventional approach to direct students, then to increase the capacity of the expected results also adheres to the

technological improvement approach in learning. The web-based system is based on the reason that by implementing a computerized or web-based two-level test model it is not only feasible and efficient but also provides an easy and familiar interface for students to answer questions.

From [61] build a web-based learning environment with a client database-application server architecture, then design a user interface to adapt to different device screen sizes; that is, students can interact with the system using a personal computer, notebook, tablet or smartphone. Each student can enter the system to review the teaching material they have learned and to take the test. When students answer test items, the system provides appropriate feedback directly, including correct answers, explanations of answers, and additional material for misunderstandings if students fail to answer the item correctly. The system structure of the online two-level test for programming learning which is named OT3PL.

5.2. RQ2: In what domains have studies on the application of educational game learning models been assessed?

During the analysis of the main study, we also collect information about the educational game domain by applying the learning model that had been studied. We get 2 assessed domains, namely in the education and health. The most dominating is in the education domain which amounts to 72 papers and for the health domain, there are only 3 papers, for primary studies in the domains shown in Table 6.

Table 6. Domains in the application of learning models in educational games

Domain	Primary Study	Number of Papers
Education	([17]; [83]; [74]; [18]; [19]; [20]; [12]; [86]; [21]; [76]; [82]; [22]; [16]; [81]; [23]; [24]; [25]; [26]; [75]; [27]; [28]; [29]; [30]; [31]; [13]; [32]; [33]; [34]; [14]; [35]; [36]; [67]; [85]; [78]; [37]; [38]; [39]; [40]; [41]; [42]; [43]; [44]; [70]; [72]; [73]; [84]; [45]; [69]; [80]; [46]; [47]; [48]; [49]; [50]; [51]; [15]; [52]; [68]; [53]; [71]; [79]; [54]; [77]; [55]; [56]; [57]; [58]; [59]; [60]; [61]; [62]; [63])	72
Health	([64]; [65]; [66])	3
	Total Overall Papers	75

In the education domain in the application of learning models in educational games, the average research shows that the implementation is in the area of formal education, namely Early Childhood Education, Kindergarten, Elementary School, Junior High School, High School, Vocational Education, Higher Education, and for non-formal education such as course activities to hone skills. In the health domain in the application of learning models in this educational game, it only consists of 3 papers applied to the epidemic by ([64]), the field of emergency handling of accidents by ([65]), and in the pharmaceutical field by ([66]). A total of 75 papers successfully answered RQ2 specifically.

5.3. What types of educational games have been assessed in applying the learning model?

We collect information about types of educational games with assessed learning models. Detailed mapping of the types of games that have applied the educational game learning model (See Appendix 3) and the ranking of game types is shown in Figure 8.

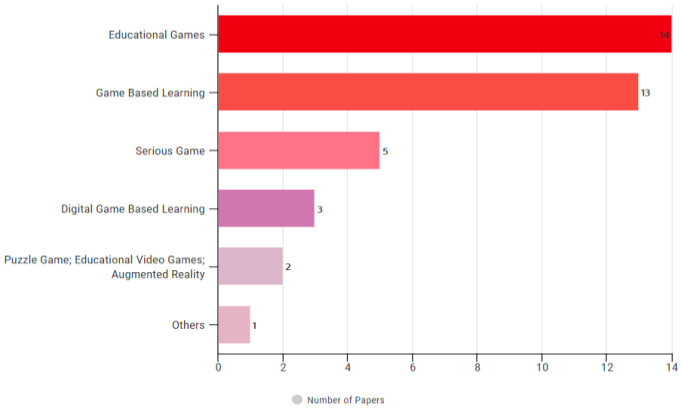

Figure 8. Ranking of types of games

In this RQ3, a total of 75 papers have answered research questions with the dominant type is the Educational Game (pure without combination), consisting of 14 papers ranked first. The second place is 13 papers with a Game-Based Learning type. For the type of Serious Game ranked third with a total of 5 papers. The fourth rank is occupied by Digital Game-Based Learning, which amounts to 3 papers. The fifth rank, each consisting of 2 papers namely Puzzle Games, Educational Video Games, and Augmented Reality. The sixth rank is occupied by other types of games, each of which is only 1 paper.

The RQ3 finding that we found interesting was the merging of various types of games into educational games. This depends on the direction of the content presented by the game. Then what's interesting is also between Educational Game and Game-Based Learning, in general, 2 types of games together build games for learning/educating purposes, but we can explain from that understanding as follows:

1. Educational Games are games that are designed explicitly with the aim of education, or that have incidental or secondary educational values. All types of games can be used in the educational environment. Educational Games is a game designed to help people learn certain subjects, develop concepts, strengthen development, understand historical events or cultures, or help them learn skills while playing. These types of games include boards, cards, and video games. Educational Games are games designed to teach humans about certain subjects and teach them skills. When educators, government, and parents are aware of the

psychological needs and benefits of learning games, this educational tool has become mainstream. Games are interactive games that teach us goals, rules, adaptations, problem-solving, interactions, all represented as stories. Educational games satisfy our basic needs for learning by giving pleasure, passionate involvement, structure, motivation, ego satisfaction, adrenaline, creativity, social interaction and emotions in the game itself while learning takes place.

2. Game-Based Learning itself has a different view, the first as a learning model and the second as a type of game, especially for educational games. In this area, Game-Based Learning is defined in the area of the game type from the educational game, which is the type of game that has determined the learning outcomes. In general, game-based learning is designed to balance subject matter with gameplay and the ability of players to maintain and apply the subject matter to the real world. Children tend to spend hours playing hide and seek, learning the steps of digital games, such as chess, and being involved in creating games. Therefore, it can be said that play and learning are the same, leading to cognitive and emotional development in social and cultural contexts. For example, the game of hiding and seek. Good hiding requires a visual and spatial perspective to determine the best hiding place, while the seeker must be skilled in looking for cues from the environment and choosing the location that is most likely for hiders among various possible places.

5.4. RQ4: In what subjects or research material has the educational game learning model been applied?

From the results of the study that we conducted, to answer this RQ4 question, we found subjects that had been made into a game that positions and educates students. In RQ4 we made two keywords namely subjects and material, because of the findings of our study that several studies do not mention specific subjects or material, but we provide an alternative if there are studies found that do not mention the two keywords or one of them by reviewing the content of the educational game, reviewing abstract, introductory, method, results, discussion even in terms of conclusions. Sometimes there are only those who mention subjects but the material is not mentioned, interestingly also when the material is mentioned then the subjects are not specifically mentioned, our way is to map the material and review the links with subjects related to the material. For this RQ4, we tried to map the various subjects that we found in applying the learning model in the educational game and then ranked based on the number of papers found in the subjects shown in Figure 9 and For detailed mapping results in each subject (See Appendix 4).

Figure 9. Subject ranking

Based on Figure 9 and Appendix 4, it can be seen that the most dominating subjects are Programming, very striking from the number of papers we found. For this RQ4, 67 papers that can answer research questions and 8 papers do not answer because they are not specifically mentioned and cannot be concluded even though we have examined but not seen the subjects or material applied namely ([67]; [68]; [82]; [69]; [77]; [86]; [78]; [79]). We are interested in giving our findings to Programming subjects as the first and most researched because these subjects are very likely to be indicated as the most difficult subjects to learn so that it requires the use of tools/media, innovation, and technology that can help understand and make it easier to understand the material contained in this Programming subject.

Programming subjects have a wide range of material that we have found from 23 studies namely basic/introductory concepts by ([20]; [81]; [55]; [31]; [48]; [54]; [53]; [61]; [17]; [35]; [13]; [41]; [15]; [74]; [51]; [19]; [26]), the basis of the algorithm by ([84]), variable by ([25]), branching control structures by ([25]; [46]), loop control structures by ([12]; [25]), search binary by ([27]), sorting algorithms by ([36]), and the concept of object-oriented programming ([27]). As for the programming languages used are ActionScript, C, C++, and Java.

5.5. RQ5: How has the impact or effect been assessed on the application of the educational game learning model?

In our study, the purpose of RQ5 is to collect empirical evidence that discusses the impact or effects of applying learning models in educational games. Of the 75 papers, all of them have discussed and demonstrated the impact/effect of the application of learning models in educational games.

From the review of the results of RQ5, it shows that the average paper has the purpose of knowing or giving an impact or effect in the form of student learning motivation which is expected from the application of learning models in the educational game that has been done ([42]; [18]; [34]; [33]; [16]; [20]; [55]; [19]; [68]; [30]; [44]; [62]; [13]; [83]; [63]; [84]; [23]; [28]), there are a number of 18 papers covering student learning motivation. The other papers have a very small amount, where they discuss the impacts/effects

in terms of learning, namely activities, learning outcomes, skills, critical thinking, understanding, learning experience, the effectiveness of learning, behavior, and knowledge. In terms of software includes the impact of user convenience, usability, user experience, user interface, interactive media elements, user behavior, design, implementation, and functionality.

5.6. RQ6: What are the evaluation techniques or instruments used in research that apply learning models in educational games?

In RQ6 from our study, it is collecting empirical evidence that discusses evaluation techniques or what instruments are used from the application of learning models in educational games. Mapping RQ6 answers (See Appendix 5) in implementing educational games in class. Then map the evaluation techniques or instruments to assess from the area of educational game software (See Appendix 6).

Based on Appendix 5 for evaluation techniques or instruments used in the implementation in the classroom there are 61 papers of different types, as many as 26 papers have dominated and presented information about experimental design evaluation techniques with the instruments used in the form of questionnaires and tests then final assessments for influence with the Independent Sample T-Test. From Appendix 6, maps evaluation techniques or instruments used from a perspective to assess the quality of software from educational games, 7 papers present this. Furthermore, 11 papers did not mention and tend not to answer RQ6, namely ([83]; [74]; [76]; [81]; [85]; [73]; [84]; [80]; [51]; [68]; [71]).

5.7. RQ7: What is the population size or sample involved in the assessment in the study by applying the educational game learning model?

In RQ7 we explored the main study to find the size of the population or sample that had been involved in the assessment in the study by applying an educational game learning model. The population size or sample dominates and is most widely used among 79-2645 peoples with 15 papers with a percentage of 31.91% as shown in Figure 10 and to map population sizes or samples in detail (See Appendix 7).

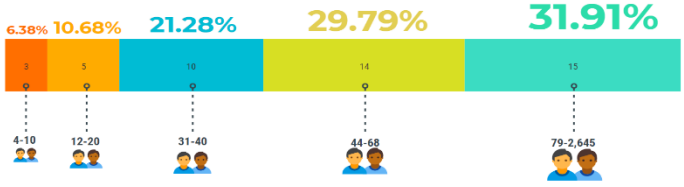

Figure 10. Population or sample distribution

Based on Figure 10, the size of 44-68 peoples is almost the highest value. The least used population size or sample is between 4-10 peoples as many as 3 papers found with a percentage of 6.38%. We conclude that in the research we found in this main study, they averaged students in actual classrooms, and the actual classrooms had an average number of students between 30-50 peoples and also found studies involving many schools and even between regions.

Of the 75 papers that we made as to the main study in RQ7, only 64 were stated to be able to answer our research question, even though there were 17 papers which did not specify but we still gave action to include the paper because it had provided sufficient information (eg in class ten vocational education or 3 schools and others) and also we are very easy to draw conclusions even though the numbers are not specifically mentioned. Then as many as 11 papers do not provide information at all and cannot answer RQ7 questions, namely ([81]; [70]; [82]; [41]; [72]; [83]; [75]; [84]; [86]; [85]; [80]).

5.8. RQ8: How much research by applying learning models in educational games for vocational education?

For this research on RQ8, we prove whether there is an application of learning models in educational games for vocational education and if there are how many papers discussing their implementation in vocational education students. For the mapping of the implementation area, the application of learning models in educational games is shown in Figure 11.

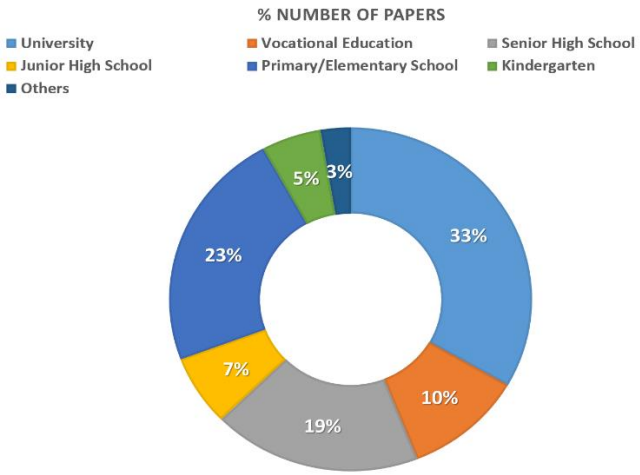

Figure 11. Mapping the implementation area

Based on Figure 11, we state that there is an application of learning models in educational games for vocational education, of the 75 papers found only 8 papers or about 10% in the implementation area for the needs of vocational education students, the rest in most of the higher education fields dominating 33 % for students in universities, non-vocational high schools, junior high schools, elementary schools, kindergartens, and others (non-formal education). In the field of vocational education with 8 papers examined by ([12]; [14]; [13]; [41]; [15]; [16]; [51]; [80]).

From our findings, which only get 8 papers that apply learning models in educational games by implementing them in the area of vocational education, with this small number in our opinion it can be interpreted that researchers

have vast space and great opportunities to conduct research in the area of vocational education in applying learning models in educational games or applying other types of technology to enhance learning in vocational education as a place to produce skilled, reliable and professional personnel.

From the research of [97] which has proven the application of Student Team Achievement Divisions (STAD) learning models on basic programming subjects for branching control structure materials assisted by flash-based learning media and Turbo Pascal 7.0 programming applications, but they are still Manually applying the STAD learning model, the manual here means that the syntax/elements of the STAD model are directly treated to students in class conditions, not digitally in learning media or educational games, but even though the conclusions from their research are manually able to provide an impact in the form of increasing the activities and learning outcomes of students in vocational education.

We also agree and one thought also from the results of the SLR conducted by [98] who have the view that vocational education and training programs must prepare students to be part of a competent workforce so that there is an effort to face all challenges, then one solution is to use computer-supported collaborative learning technology in all vocational education backgrounds, where technology has offered various types of innovative new learning possibilities for vocational education, the opportunities for this are overwhelming because it has not been fully mentioned, with this effort so that it can support and facilitate the learning process of vocational education, one example is learning with the help of educational simulation games.

6. Threats to Validity

The SLR currently has several factors that might have influenced its validity. As with all reviews, it is limited by the search terms used, journals entered and the length of time the paper is published because they limit the work done. To overcome the effects of these limitations, we decided to apply the guidelines proposed by [7] and, according to this guide, we defined the research protocol. By respecting human resources, a single researcher chooses candidate studies. Given a large number of publications found for search engines, this could be a threat to the validity of the study because of the possibility of the human error itself including us as researchers conducting this study. Therefore, for the selection process to be as precise as possible, it was decided to carry out the selection process in two stages, that the dubious candidate could be assessed more deeply and accepted or rejected in the second stage. The same limitations exist in all review procedures. This work can be improved by involving more researchers in all review processes.

Table 7 summarizes the answers to the most frequently used and dominant research questions in the study of applying learning models in educational games that we have found in this study.

Table 7. Summary information

RQ	Aspects	Most Frequent Answer
RQ1	Learning Models	Problem Based Learning
RQ2	Domain	Education
RQ3	Game Type	Educational Games
RQ4	Subjects or material	Programming
RQ5	Impact or Effect	Motivation to Learn
RQ6	Evaluation Techniques or Instruments	Experimental Design/Questionnaire and Test
RQ7	Population or sample size	Among 79-2,645 peoples
RQ8	Implemented in the Area of Vocational Education	There are 8 papers

Finally, to assess the quality of each selected study and whether this study provided us with sufficient information to get conclusions about the specified research questions, we defined the Quality Assessment Questionnaire. For each question, we evaluate the YES answer with a value of 1 or NO with a value of 0 and we conclude that out of 75 papers carried out the quality assessment process is a percentage of 84% of the QA covered by YES values and 16% covered by NO values. Whereby calculation, if all QA values are 1, then 8 * 75 is obtained by a total of 600, the value of YES with a total of 504, and the value of NO 96 is then calculated as a percentage value.

This is a subjective evaluation method because it depends on the evaluator himself. But this process allows us to add other steps to the selection process by the information obtained from each paper. The Quality Assessment step can be improved by defining the higher quality questions that we have done on the questions for each QA that are indeed approaching the direction of the answers for each RQ so that the effect will provide a more realistic view on the quality of the selected paper.

7. Conclusion and Future Works

7.1 Conclusion

From the studies that we have done, we identified 75 papers that prove the application of learning models in educational games with various aspects that are in the domain, types of educational games, subjects or material, impacts or effects, evaluation techniques or instruments, population or sample size, and prove the presence or absence of implementation in the area of vocational education. We have arranged, classified, and collected information obtained in providing answers to the eight research questions set. The classification of research questions along with these answers can provide a baseline for further research related to the application of learning models to educational games. The results of our study are for answers to RQ1: the most widely used and applied learning model in educational games is a Problem Based Learning with a total of 6 papers from which 75 of them conducted primary studies with a percentage of 100% discussing the learning model. Answer RQ2: the most dominating domain is in the Education domain with 72 papers. Answer from RQ3: the most dominating type of educational game is

Educational Games (pure without combination) with 14 papers in total. For answers to RQ4: the dominating ones are Programming subjects with a total of 23 papers. The answer to RQ5: found the average paper dominates the impact or effect to find out student learning motivation with a total of 18 papers.

For answers to RQ6: the evaluation technique used is Experimental Design with Questionnaires and Test instruments dominated with a total of 26 papers. Answer RQ7: population or sample size that has been involved and dominates between 79-2,645 peoples with 15 papers with a percentage of 31.91%. Finally, for RQ8 with the answer there is the application of a learning model in educational games for vocational education, out of 75 papers only found 8 papers in the implementation area for the needs of vocational education students, the rest in the area of higher education/university, secondary school not vocational, elementary school, kindergarten, early childhood education, and non-formal education. Of the 75 papers used as primary studies in the final process of quality assessment, the percentage was 84% with the total value of YES answers as much as 504 and for answers NO at the percentage of 16% with the total value of the answer NO as much as 96.

7.2 Future Works

The studies we produce can provide direction, gaps, broad opportunities, and considerations to researchers who are interested in planning, designing, and implementing the elements/syntax of learning models into educational games, then providing direction on what domains, types suitable educational games, on what subjects or material, use evaluation techniques or instruments and involve how much population or sample, what impacts/effects are expected, and for areas of formal/non-formal education. The recommendation for further research is to improve the quality of this study by increasing the number of authors' involvement and other methods so that our study can be of good value and more valid, and so that more research can implement educational games in an effort to improve learning with utilizing the capabilities of technology to support the learning process especially in vocational education.

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Appendix 1. Outline of the SLR process

Month	*Activity*	*The Results Achieved*
September 2018	• Determine the SLR title • Determine SLR research objectives and questions • Development of the SLR protocol • Revised the draft SLR protocol and improvements • Search process	• SLR title (final) • SLR research objectives and questions (final) • Draft protocol • The first version of the SLR protocol • List of publications
October 2018	• Search process (continued) • Elimination of publications by year • Elimination of publications based on duplicated indications • Elimination of publications based on game type/genre • Improved SLR protocol (revision) • Selection of B1 publications (title and abstract analysis) • B2 publication selection (full-text analysis)	• List of publications (final) • List of paper results that have escaped elimination by year • List of results of papers that have escaped elimination based on duplicated indications • List of paper results that have successfully escaped elimination based on the type/genre of the game • The second version of the data extraction and SLR protocol process • List of publications that have passed selection B1 • List of publications that have passed B2
November 2018	• Improved SLR protocol (revision) • Data extraction process • The quality assessment process for the main study • Final results from quality assessment for the main study • Improved SLR protocol (revision)	• The third version of the data extraction and SLR protocol process • Mapping of publication data • Evaluation results from the assessment of the main study quality • List of papers resulting from quality assessments for the main study • The fourth version of the data synthesis and SLR process
December 2018	• The process of data synthesis • Final report	• Results in the form of research questions that can be answered from the paper • Draft the first version of the final report
January 2019	• Final report • Preparation of sending SLR papers to the journal	• Draft second version final report • Draft third version final report • Fourth version final report (final) • Preparation of sending SLR papers to journals

Appendix 2. Mapping the application of learning models in educational games

Learning Models	Primary Study	Database	Number of Papers
Problem Based Learning	([17]; [83]; [74]; [18]; [65]; [19])	Science Direct; ERIC; ERIC; ProQuest; IEEE	6
Problem Based Learning and ARCS model (the model for the motivating stage)	([20])	IEEE	1
Active Learning Strategic	([66])	ProQuest	1
Cellular Automation Algorithm (CAA) and Information Processing model	([12])	IEEE	1
Chem Dongeuon Approach	([86])	Science Direct	1
Choice-Based Assessments and Game-Based Approach	([21])	ERIC	1
Classroom Approach	([76])	ERIC	1
Collaborative Learning	([82]; [22])	ERIC; Science Direct	2
Collaborative Learning and Universal Design Learning	([16])	Science Direct	1
Collaborative Learning and E-Learning	([81])	IEEE	1
Collaborative Learning and Learning Design	([23])	ERIC	1
Collaborative learning and Model Analysis 3D Green	([64])	EBSCO	1
Collaborative Learning and Problem-Based Learning	([24])	ERIC	1
Computational Problem Solving	([25])	IEEE	1
Computational Thinking Method	([26])	ERIC	1
Computer-Assisted Language Learning (CALL)	([75])	ERIC	1
Constructivist Approach	([27])	IEEE	1

Cooperative Learning	([28]; [29])	EBSCO; Science Direct	2
Educational and Learning Theories	([30])	ACM Digital Library	1
Funke Method	([31])	IEEE	1
Game-Based Learning Model	([13]; [32])	Science Direct; ERIC	2
Game-Based Learning, Content and Language Integrated Learning (CLIL), and Collaborative Learning	([33])	ERIC	1
Gamified Learning	([34])	ERIC	1
Higher Order Thinking Skills (HOTS), Cooperative Learning, and Collaborative Learning	([14])	Science Direct	1
Instructional Design Model and Game Attributes Taxonomy	([35])	Science Direct	1
James Martin Approach	([36])	Science Direct	1
Learning Analytics (LA)	([67]; [85]; [78])	IEEE; Science Direct; Science Direct	3
Learning Approach	([37])	ERIC	1
Learning Object	([38])	IEEE	1
Thematic Method	([39])	IEEE	1
Mix Method (Tangible Object Method and Montessori Theory Educational Approach)	([40])	EBSCO	1
Learning Resources	([41])	IEEE	1
Life Cycle Assessment (LCA)	([42])	Science Direct	1
Outdoor Learning and Three Layered Thinking Model	([43])	IEEE	1
Pedagogical Approach	([44]; [70])	EBSCO; SpringerLink;	2
Personalize Learning Model	([72])	IEEE	1
Cognitive and Constructivist Approaches	([73])	IEEE	1
Pedagogical Teaching and Learning	([84])	ERIC	1
Pervasive Learning	([45])	ERIC	1
Playing Learning	([69])	Science Direct	1
Problem-Centered Learning	([80])	IEEE	1
Problem-Posing Model	([46]; [47])	Science Direct; IEEE	2
Problem Solving Model	([48]; [49]; [50]; [51]; [15])	IEEE; Science Direct; Science Direct; IEEE; IEEE	5
Problem Solving Model and Bayesian Network Method	([52])	ERIC	1
Role Playing Approach and Collaborative Learning	([68])	ACM Digital Library	1
Scratch-Based Game Activities	([53])	ERIC	1
Project Based Learning and Computer Supported Collaborative Learning	([71])	IEEE	1
Serialist Approach Learning, Holistic Approach Learning, Problem Solving Model Games, and Personalization and Customization Approach Game Environment	([79])	Science Direct	1
Student Centre Approach and Instructional Learning	([54])	ACM Digital Library	1
Situated Learning Theory	([77])	ERIC	1
Student-Centered Learning	([55]; [56]; [57]; [58])	IEEE; EBSCO; EBSCO; ERIC	4
Teaching, Retention of Knowledge, and Student Achievement	([59])	ERIC	1
Team Games Tournament Model	([60])	ERIC	1

Two-Tier Test-Based Learning System, Conventional Learning, and Technology Enhanced-Learning Approach	([61])	EBSCO	1
Ufractions (Ubiquitous Fractions)	([62])	EBSCO	1
Telecollaboration Learning	([63])	ERIC	1
Total Overall Papers			75

Appendix 3. Mapping the types of educational games

Types of Educational Games	Primary Study	Number of Papers
2D Digital Game-Based Learning	([37])	1
3D Game	([30])	1
3D Virtual Environment Gamification	([63])	1
All Games	([35])	1
Augmented Reality	([40]; [16])	2
Card Pairing Game	([56])	1
Choice-Based Assessments Game	([21])	1
Digital Game-Based Learning	([57]; [77]; [42])	3
Digital Game-Based Learning and Technology Enhanced Learning	([14])	1
Educational Adventure Game	([49])	1
Educational Games	([59]; [66]; [78]; [52]; [29]; [67]; [55]; [12]; [43]; [31]; [48]; [39]; [46]; [54])	14
Educational Marble Games	([44])	1
Educational Mobile Game and Serious Game	([62])	1
E-Learning	([81])	1
Educational Video Games	([68]; [85])	2
Game-Based E-Learning	([24])	1
Educational Video Games and Game-Based Learning	([22])	1
Game-Based Learning	([25]; [28]; [69]; [13]; [71]; [38]; [41]; [15]; [73]; [74]; [33]; [79]; [50])	13
Game-Based Learning (Kinect)	([32])	1
Game-Based Learning and Serious Game	([64])	1
Interactive Language Learning Games	([75])	1
Interactive Learning	([47])	1
Learning Media and Adventure Game	([72])	1
Kahoot Digital Games and Game-Based Learning	([34])	1
Mobile Collaborative Learning Games	([82])	1
Mobile Game and Serious Game	([58])	1
Mobile-Assisted Language Learning and Game-Based Learning	([45])	1
Puzzle Game	([20]; [51])	2
Scratch Based Game	([53])	1
Serious and Video Games	([70])	1
Scratch Based Game and Game-Based Learning	([17])	1
Scientific Discovery Games and Game-Based Learning	([23])	1
Serious Educational Games	([86])	1
Serious Game	([83]; [76]; [84]; [65]; [80])	5
Web-Based Learning	([36])	1
Web-Based Learning Environments	([61])	1
Web-Based Simulation Game	([18])	1
Web Digital Game-Based Learning	([19])	1
Web-Based Games Learning	([60])	1
Visual, Lightbot and Scratch Visual Games	([26])	1
Virtual Reality and Game-Based Learning	([27])	1
Total Overall Papers		75

Appendix 4. Mapping topics/subjects in educational games

Subjects	Primary Study	Number of Papers
Artificial Intelligence Learning	([24])	1
Language	([57]; [34])	2
English and Geography	([33])	1
Irish	([75])	1

German language	([44])	1
Italian language	([45])	1
American Sign Language	([32])	1
Bacteriology	([58])	1
Epidemic	([64])	1
Graphic Design	([21])	1
Cyber Colonization	([72])	1
Biology	([59])	1
Pharmacy	([66])	1
Physics	([30]; [52])	2
Physics and Chemistry	([73])	1
Chemistry	([28])	1
Living Environment	([71])	1
Graph Theory	([38])	1
Culture	([63])	1
Entrepreneurship	([76])	1
Operation Management	([18])	1
Surrounding Environment	([85])	1
Manufacture	([42])	1
Mathematics	([43]; [39]; [62]; [56]; [47]; [37]; [50]; [29]; [60])	9
Automotive	([16])	1
Quantum Mechanics	([80])	1
Programming	([20]; [81]; [55]; [12]; [31]; [48]; [25]; [36]; [46]; [54]; [53]; [61]; [17]; [35]; [13]; [27]; [41]; [15]; [74]; [84]; [51]; [19]; [26])	23
Computer system	([49])	1
Coloring, 2D and 3D concepts	([40])	1
History	([70]; [83])	2
Vocational Education Skills	([14])	1
Science Education	([23])	1
Emergency Handling in Accidents	([65])	1
Children's Play Environment	([22])	1
	Total Overall Papers	67

Appendix 5. Evaluation techniques or instruments from the point of view in the classroom

Evaluation/Instrument Techniques	Primary Study	Number of Papers
Quasi-Experimental/Questionnaire; Test; Independent T-Test	([25]; [14]; [18]; [34]; [42]; [53])	6
Experimental Design/Questionnaire; Test; Independent Sample T-Test	([61]; [44]; [17]; [13]; [38]; [59]; [65]; [79]; [50]; [19]; [32]; [26]; [60]; [43]; [20]; [12]; [36]; [46]; [56]; [57]; [58]; [21]; [33]; [55]; [39]; [64])	26
Survey; Observation; Interview/Questionnaire; Test;	([28]; [63]; [30]; [62]; [40]; [27]; [41]; [15]; [45]; [75]; [23]; [37]; [77])	13
Structural Equation Modeling to Examine/Test	([52])	1
Quality Assessment Tool Dr. Scratch/Questionnaire	([31])	1
Self-Regulated Learning Approach; Testimonials/Questionnaire; Test	([72])	1
Basic Computer Knowledge Test; Computer Assembly Knowledge Test/Questionnaire	([49])	1
Learning Assessment Instruments; Content validity; Construct Validity/Questionnaire	([54])	1
Qualitative Study	([82]; [70]; [66]; [86]; [22])	5
Quantitative Study	([78])	1
Qualitative Comparative Analysis	([35])	1
Ordinary and Extraordinary Test; After and Before Application	([24])	1
Cross-Sectional Evaluation	([16])	1
ANCOVA	([29])	1
System Monsakun (assessment of the history of student actions, detecting barriers, generating new task arrangements, and providing personalized assignments to students)	([47])	1
	Total Overall Papers	61

Appendix 6. Evaluation techniques or instruments from a software perspective

Evaluation/Instrument Techniques	Primary Study	Number of Papers

Usability/Questionnaire	([43])	1
User Experience/Questionnaire	([43])	1
Technology Acceptance Model (TAM)/Questionnaire	([67])	1
Stealth Assessment/Questionnaire	([69])	1
Black Box Testing/Questionnaire	([36])	1
Media Validation and Material/Questionnaire	([72])	1
Fishbein Model (attitude toward application)/Questionnaire	([48])	1
Total Overall Papers		7

Appendix 7. Population mapping or sample size

Population or Sample Size	Example of Division	Primary Study	Number of Papers
4-10	-	([20]; [58]; [45])	3
12-20	(N: 17; Girls: 9; Boys: 8) or (19 Educational Games)	([63]; [33]; [77]; [16]; [35])	5
31-40	(N: 34; Group A: 20; Group B: 14)	([27]; [67]; [48]; [56]; [13]; [78]; [32]; [26]; [39]; [12])	10
44-68	(N: 60; Class 1: 20; Class 2: 20; Class 3: 20)	([55]; [31]; [54]; [53]; [14]; [38]; [15]; [23]; [37]; [18]; [59]; [50]; [42]; [51])	14
79-2,645	((Study 1 = N: 109; Females: 63; Males: 45; and 1 not reported), (Study 2 = N: 31; Females: 22; Males: 9), (Study 3 = N: 97; Females: 46; Males: 51))	([25]; [61]; [62]; [44]; [64]; [57]; [21]; [69]; [17]; [34]; [65]; [52]; [79]; [60]; [29])	15
There is a population or sample but no specific size is mentioned	(New Computer Science students) or (Secondary education with students aged 15-16 years)	([43]; [36]; [46]; [49]; [68]; [30]; [28]; [40]; [71]; [47]; [73]; [74]; [76]; [24]; [66]; [19]; [22];	17
Total Overall Papers			64