The Effect of the Intelligent Tutoring Systems on the Education

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Abstract:

Traditional education systems have developed very slowly although they have been used for centuries and cannot handle different learning styles and preparation levels. Many students who interact with one teacher who cannot answer each student's needs are identified by this system. As a result, some students may be frustrated and unable to achieve their educational opportunities. An Intelligent Tutoring System (ITS), a software that provides students with personalized instruction tailored to the style and speed of students, is of interest to teachers to improve student learning. To assess the effectiveness of ITS, a systematic review of the latest literature was performed by using carefully renovated protocols that provide data to support meta-study of the effectiveness of ITS. The research question that guides this article is: "Does ITS enhance the education of the students more than the traditional education?" One way ANOVA test, t-test, and KNIME program were performed. The results that came from this study back the conclusion that ITS significantly improves students learning more than traditional teaching methods.

Keywords: *Cognitive tutor, intelligent tutoring system, intelligent coaching, intelligent agent system.*

1. Introduction

The education system that is called traditional that have been used for many centuries have developed very slowly and cannot manage with different training styles and levels of preparation. Many students who interact with an individual teacher who does not meet the students' individual needs are identified by this system. Therefore, some students may feel frustrated and unable to reach their educational opportunities. The Intelligent Tutorial System (ITS), an IT application that provides students with tailored tutoring for the student's pace and style of learning, has been of researchers' interest to improve student learning. The learning process that uses computers in it has been an area of interest for pedagogical researchers for almost a century. The purpose of these researchers was to build computer systems that would help students learn about specific areas. One of the first computer systems in education, such as Pressey' teaching machine in 1926, published questions that have multiple-choice with teacher's answers. In the 1970s, progress in computer technology has led to the Artificial Intelligence (AI) introduction into these systems. Integration of Artificial Intelligence with computers is called as an Intelligent Tutoring System (ITS) system. ITS has been developed and this program can simulate the emotional and cognitive status of students to adapt courses (Nesbit et al., 2014. p. 99). These ITS systems are used in many parts of the education system, such as chemistry, physics, mathematics and computer science. Although many of the ITS have evolved, most of these systems are only used in a research environment as they are difficult to develop and complicate the difficulty of reliable and flexible systems (Mitrovic et al., 2003. p. 173). ITS may be the solution for educational systems. The learning environment is one of the greatest benefits of ITS. The purpose of this article is to answer the following question: Does the educational ability of ITS students improve with regard to traditional teaching methods? This article answers the question of introducing a systematic review of many studies on how intelligent tutoring systems influence learning in education.

2. The Systematic Review and Intelligent Tutoring Systems

2.1 Systematic Review

One way to collect summaries of available surveys is called a systematic (Budgen et al., 2006. P. 1051). A systematic review differs from traditional one, which is often incorrect and is considered unreliable scientific method. The traditional review has a limited ability to generalize the value of a certain number of studies, and the researcher can postpone the review (Tranfield et al., 2003. p. 207). On the other hand, a systematic review should guarantee a complete and impartial synthesis. In addition, a systematic review should be conducted in accordance with a procedure that is clearly defined that should be understood by other researchers (Kitchenham et al., 2007. p. 1051). The systematic review includes a three-stage process: planning, conducting and documenting the review.

2.1.1 Planning the Review

This step involves both setting up and confirming the test report and requiring that the definition of the application study be included in the evaluation (Kitchenham et al., 2007. p. 1051). The planning of the study includes more similar steps, including the need to identify changes, revised system, problem identification / research, development of protocol review and evaluation of protocol review. Determine whether it is necessary to adapt the requirements of scientists any information on the subject to compile, to consider neutrally. This can be done to issue a general statement about the object, which is impossible because of the individual tests (Kitchenham et al., 2007. p. 1051). At the beginning of the survey, many organizations do not have time to gather information about a systematic review of their subject matter, so they asked scientists to do the work. In this case, these organizations must set up a startup document that lists the desired work. The definition of the research problem is an important part of the systematic review, as this question leads the whole approach to a systematic review. The evaluation of the development of the protocol determines the methods used in this systematic review. To reduce the probability of error in testing, you must provide a standard protocol. The protocol used in the methodology of this document contains 9 steps (Kitchenham et al., 2007. p. 1051).

2.1.2 Conducting the Review

Once you have set a specific protocol, you can start the general description. We developed this study protocol by following these steps: determining the studies, selecting the tests, evaluating the quality of the study, extracting data and synthesizing the data. The definition of the research is to investigate the work of the teacher through the objective tactics; Then to start evaluating these results to select those results that are important, called process test selection. Then, the quality of the tests needed to verify the quality of the results is assessed. In other words, the researcher determines if these studies minimize the bias or not. In the data extraction step, the record of the information from the studies is constructed, including documenting the number of studies that have been checked, the number of participants in the studies, etc. Finally, organizing and summarizing the results from the studies is performed.

2.1.3 Documenting the Review

This is the last step in systematic review. In this step, we documented the results of the review.

2.2 Intelligent Tutoring Systems (ITS)

2.2.1 Introduction to Intelligent Tutoring Systems

In the 1970s, computers used artificial intelligence (AI) in education. Artificial intelligence leads to a better understanding of knowledge and the creation of machines to do what people can do cleverly. AI tutors work with students that have different abilities, allow collaboration, and integrate agents that are conscious of students' cognitive, affective, and social characteristics. These agents have the ability to recognize learning disabilities, communicate and replay information to the students as necessary. Lead and track progress in content-based learning, common problems, and student movement opportunities. The methods of artificial intelligence can be called self-help teachers, because teachers can qualify their own education (Shneyderman et al., p. 2006). ITS is a computer program that uses artificial intelligence to a teacher who knows who and how it teaches. ITS systems can meet the needs of students. In other words, ITS manages students’ knowledge and evaluates students' abilities. Today, ITS is a system that meets the needs of many students (Shorbe et al., 1988, p. 1). Researchers have started focusing more on ITS for two reasons: the research needs and the practical needs. They want to know more about processes that contribute to the educational interaction. Because the ITS lies at the intersection of computer science, cognitive psychology, and educational research, it provides the researchers with a very good environment for many theories from cognitive psychologists, AI scientists, and educational theorists. Furthermore, some results cannot be reached by using human tutors but can be reached by using ITS. The main reason for using Intelligent Transportation Systems is that they provide an individual learning environment that can meet the needs of students.

2.2.2 Architecture of Intelligent Tutoring System

ITS has many modules that help it to do its job. Figure 2.1 illustrates the ITS architecture.

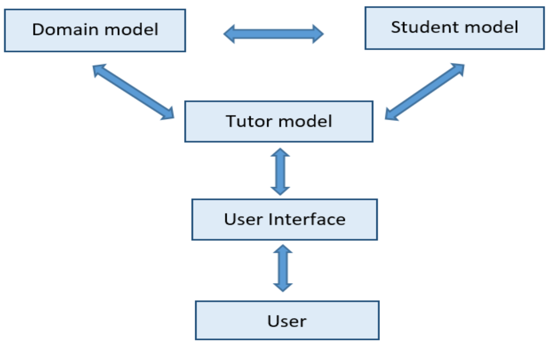

Fig. 2.1. The ITS components

The ITS has four different modules: the domain, the students, the teachers, and the learning environment (or the user interface) (Mendjoge et al., 2016. p. 2508). The ITS learners' learning environment (user interface) provides questions about the ITS module to communicate with students. The students will present a solution to this question in the same way. The Domain module has the knowledge about the subject that the ITS teaches so that it has the correct answers to the questions. The form provides information about students, including solutions for students. This module depends on the information that the Domain module provides, so it can choose which solution is correct and which is not. In addition, a training module uses the student module responsible for information gathered on behaviors and characteristics of the student so that he or she can choose the best one for each student. Students will receive these comments through the Learning Environment module. The module of the student is updated according to the information accumulated by the student in these subjects.

3. Methodology

This part explains the protocol used in this document to collect and analyze the documents that deal with the effects of ITS and this protocol is explained as follows:

3.1 Background

Traditional education has many problems linked to the use of a teacher who maintains control over the students' entire educational experience. This system led to many problems, such as the difficulty for students with varying levels of preparation to learn effectively within a system that does not account for differences. As we know, not all students have the same brain or capacity for learning, which can cause them frustration when they're unable to learn in traditional classrooms. They need an education system that teaches to their ability.

These reasons and many other reasons led me to think about ways to improve this system. An ideal solution would be to provide one teacher for every student because one-to-one teaching has a high degree of success. Teachers can know their students' ability and what they need if they teach them on a one-on-one basis. However, this solution is very expensive and nearly impossible. 36

For these reasons, Woolf (1988) suggested that using ITS may help to solve this problem (Shorbe et al., 1988, p. 1). After reading that suggestion, we started looking for the effects of ITS on the education system in general. As a result of my search, we found thousands and thousands of academic papers discussing ITS. Because of this huge number of papers, using the systematic review to construct an objective summary of them is the best way to provide the evidence of the effectiveness of the ITS. In contrast to a traditional review, systematic review provides unbiased and rigorous review.

3.2 The Research Questions

Does intelligent tutoring system improve learners' learning skills more than the traditional learning approach?

3.3 Search Process

The systematic review goal is to find studies which can answer the questions of the research. To do this, we follow the strategy described in Figure 3.1. The results of the survey were heavily influenced by the keywords and databases we selected.

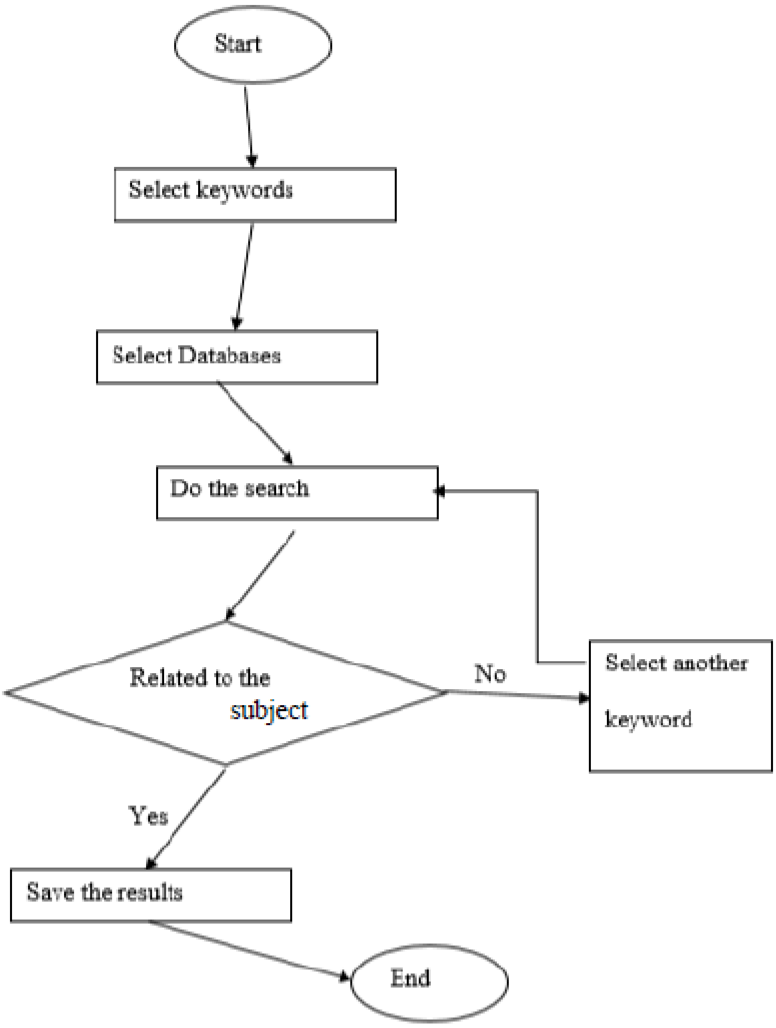

Fig.3.1. The search strategy

The work was carried out on researches in the field of ITS, completed after 1990 using the following bibliographic databases: IEEE, Eric, PsycINFO (psychology), citing science, social sciences, direct sciences, applied science, Google Scholar).

We have used the following keywords: (Cognitive Teacher, Intelligent Tutoring System Intelligent coaching, and Intelligent Agency System). The first study shows 32.144 titles. After reading the abstracts for all, there were only 210 titles. The criteria for inclusion and exclusion have been applied to other materials and 45 articles and papers have been identified.

3.4 Study Selection Criteria

The study selection criteria were used to decide which papers are excluded or included in this systematic review.

For papers to be included in this systematic review, the following criteria must be met:

1. Papers should consider the effects of ITSs on learning. All other papers were excluded.
2. Papers including ITS learning experiences were included. Other studies that focused on other areas, such as military, were excluded.
3. Papers comparing the effects of STIs on individuals using ITSs with those using them are not included. Others were excluded.
4. Papers published between 1990 and 2017 and published in English were included. The year 1990 was chosen as the beginning of the year because, at that time, many studies began on the effectiveness of ITS.
5. Papers that can be accessed online or on the Wright State University library website are included.
6. Papers with adequate results and statistics have been included.

3.5 Study Selection Procedures

This protocol defines how the selection criteria were applied to the papers (for example, how disagreements between reviewers were resolved and how many evaluators evaluated each preliminary study). In this article, we work on the evaluation of each paper, so we chose the selected papers according to the criteria described by the predefined protocol. When we are not sure about a paper, we asked clarifications from Dr. Rizki and Dr. Raymer. The rejected papers were also verified by us and verified twice to ensure that they were not related to what this document attempts to focus on.

3.6 Study Quality Assessment Checklists and Procedures

The systematic review for this paper on the effects of the ITS was evaluated using the the Center for Reviews and Dissemination (CDR) Database of Abstracts of Reviews of Effects (DARE) criteria of the York University (Kitchenham et al., 2007. p. 1051).

3.7 Data Collection

Once the papers in the systematic review were identified, data collection began. As mentioned in section 3.3, the data in this document is collected through a manual search procedure. Research has been conducted on ITS studies since 1990. After gathering this information, we began to extract the following data from each source:

1. General information such as: authors, title, source, and year of publication.
2. Study features such as: characteristics of the participants, eg sample size, age, gender, etc.
3. Criteria to include and exclude these papers.
4. Results of these studies, such as: • standard deviation, data average, etc.
5. Other information available and relevant to the studies such as graphs, charts, etc.
6. Summary of studies.
7. All comments were requested.

3.8 Data Synthesis

Data synthesis involves collecting and summarizing the results of the selected primary studies. The data synthesis is already specified in the review protocol. The extracted data was descriptively and quantitatively synthesized in such a way to answer the paper question, which is defined in the review protocol.

In the descriptive synthesis, the information extracted from the studies is related to intervention, population context, outcome, etc. In the quantitative synthesis, we used a paired t-test and a one-way ANOVA test to represent the results.

3.9 Reporting the review (Dissemination)

At this stage the results of the papers are shown so that this is the last phase of the systematic review.

4. Results

These studies involved 12,105 students. This distribution of students is as follows:, 2,666 physics students, 1093 computer students, 186 physiological students, 7,147 mathematics students, 76 undergraduate students and 937 reading students. An analysis of the data extracted from these documents showed that most of them support the effectiveness of students' ITS activity. To analyze the 45 documents' data extracted - these documents are shown in (Table 5) in the appendix - we used the corresponding t-test and one-way ANOVA test. A one-way ANOVA test identifies the difference between the ITS group and the control group, whereas the T-test compares the average scores of these groups. Before trying to find the results of these two tests, we had to find the standard deviation of the mean for each primary and all articles as one, because they were used as inputs to test the unique meaning of ANOVA. The main topics for which we have in mind standard deviations are informatics, physics, mathematics, physiology, accounting and reading. The results are shown in the following figures 4.1-4.7:

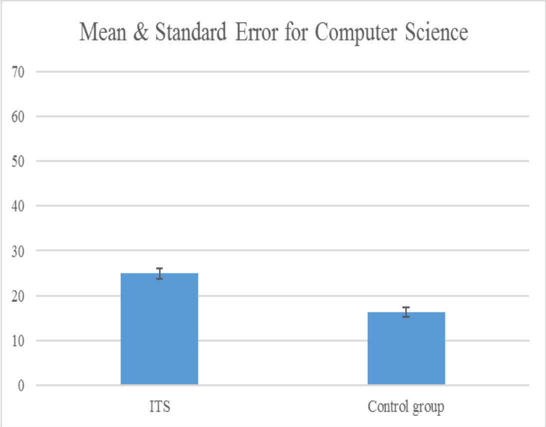

Fig. 4.1, Computer Science mean and standard error of the mean for ITS and control group

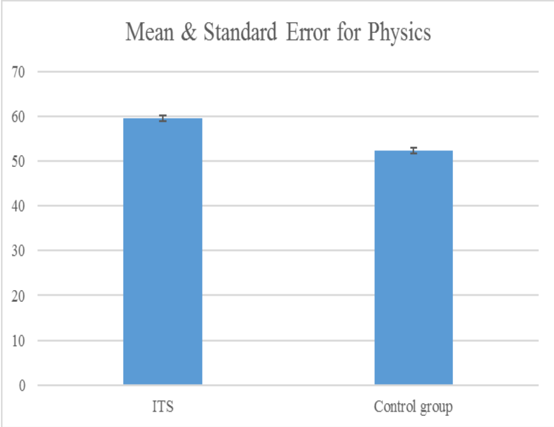

Fig. 4.2, Physics mean and standard error of the mean for ITS and control group

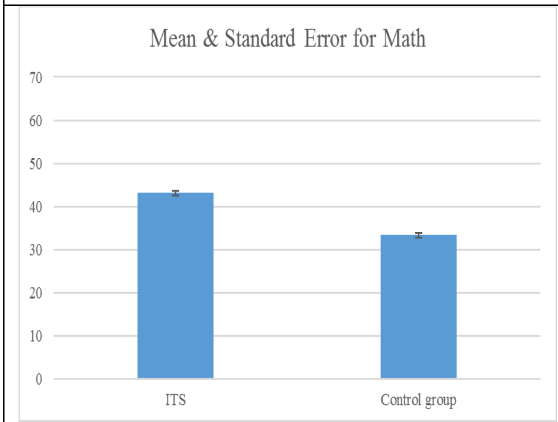

Fig. 4.3, Mathematics mean and standard error of the mean for ITS and control group.

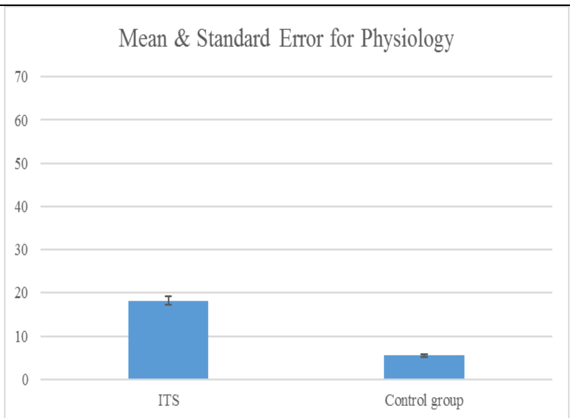

Fig. 4.4, Physiology mean and standard error of the mean for ITS and control group.

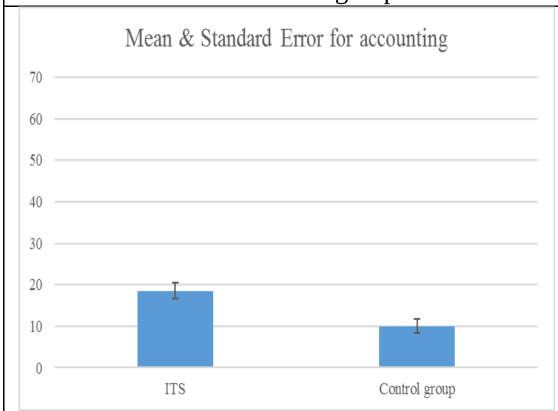

Fig. 4.5, Accounting mean and standard error of the mean for ITS and control group.

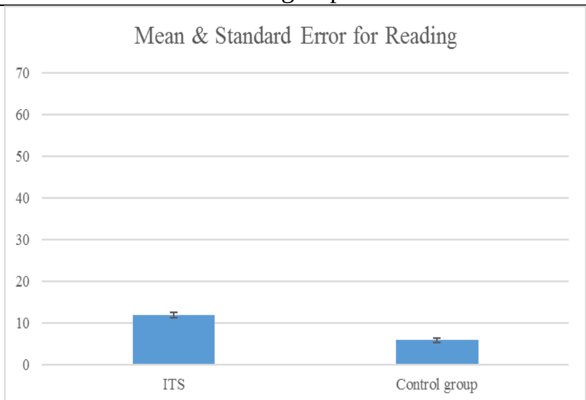

Fig. 4.6, Reading mean and standard error of the mean for ITS and control group

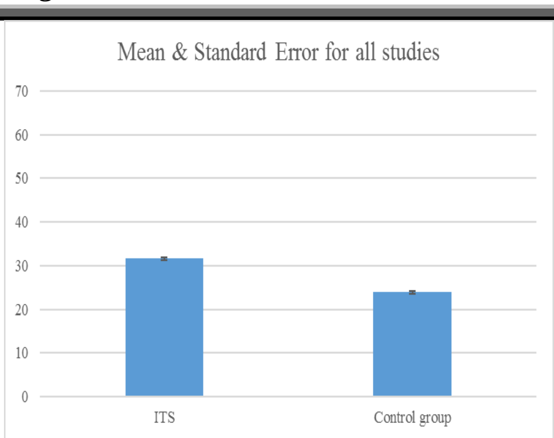

Fig. 4.7, All studies' mean and standard error of the mean for ITS and control group.

The average gain grade of students using ITS for their education in all disciplines was higher than the average for students who did not use ITS. That means there is an improvement that ITS brought to students' learning. To prove this point, we performed one way ANOVA test and t-test, and these tests' result are shown in Tables 1 and 2, respectively.

Table 1. A Comparative Overview of Students' Mean Scores and Their t-test Results

	ITS group	Control group	Statistical significance
All studies Mean (SD)	31.6(29.2)	23.9(28.2)	P<0.0001
Computer science Mean (SD)	24.9(26.0)	16.2(25.6)	P<0.0001
Physics Mean (SD)	59.5(24.3)	52.401(23.7)	P<0.0001
Mathematics Mean (SD)	43.1(34.9)	33.3(32.9)	P<0.0001
Physiology Mean (SD)	18.2(10.3)	5.5(3.5)	P<0.0001
Accounting Mean (SD)	18.5(12.0)	10.0(10.0)	P=0.0013
Reading Mean (SD)	11.7(13.3)	5.775(11.3)	P<0.0001

Table 1 shows that ITS groups (groups studied with ITS) have a higher average profit for all areas of study than other groups that do not use ITSs in training, and showed significant improvement in the t-test, P values were less than 0 , 0001. In all studies, as one, the average gain was 31.6 ITS groups, while the mean value of the gain of the control group was 23.905, and the estimates showed a significant improvement (P <0.0001). These results showed that ITS applies a positive impact on student learning and provides a noticeable improvement over time. The one way ANOVA test is used to show the differences between the control and the ITS groups.

This model has been chosen because it is the best suitable way for statistical analysis of tests involving more than two groups (Jeremi et al., 2009. p. 111). Table 2 shows the results of ANOVA for ITS and control groups.

Table 2. Statistical Analysis of the Mean Scores for ITS and Control Group

	ITS group	Control group	F-value	P-value
All studies Mean (SD)	31.6(29.2)	23.9 (28.2)	220.1	0.000
Computer science Mean (SD)	24.9 (26.0)	16.2 (25.6)	30.7	0.000
Physics Mean (SD)	59.5 (24.3)	52.4 (23.7)	58.0	0.000
Mathematics Mean (SD)	43.1 (34.9)	33.3 (32.9)	147.1	0.000
Physiology Mean (SD)	18.2(10.3)	5.5(3.5)	125.9	0.000
Accounting Mean (SD)	18.5(12.0)	10.0(10.0)	11.1	0.001
Reading Mean (SD)	11.7(13.3)	5.7(11.3)	55.4	0.000

5. LATENT DIRICHLET ALLOCATION

5.1 Latent Dirichlet Allocation

Latent Dirichlet Allocation (LDA) is a probabilistic productive model. The main idea of the LDA is to present the documents in the form of random mixtures of confidential themes. Each theme there is characterized by a distribution according to the word (Reed. 2012. p. 1). In other words, the LDA is a way of identifying text documents that use this idea to discover what common themes in your documents are and what common words are. It is thought that the LDA exhibits a thematic model and that in 2003, three scientists were introduced as graphic models: David Blei, Andrew Ng and Michael Jordan.

5.2 KNIME Analytics

Konstanz Information Miner (KNIME), which is illustrated in Figure 5.1, is an integration program, data analysis and reporting platform. KNIME's idea is to create a program that can visually mix various data into processing and analysis. KNIME combines elements of data transfer and machine language learning with modular concepts. The KNIME Graphical User Interface (GUI) enables multiple components to be formed for processing and data analysis. This program is able to execute the LDA that it receives as input (Al-Aqbi. 2017. p. 55). This program was created by the Constance University Software Engineers Group in 2004.

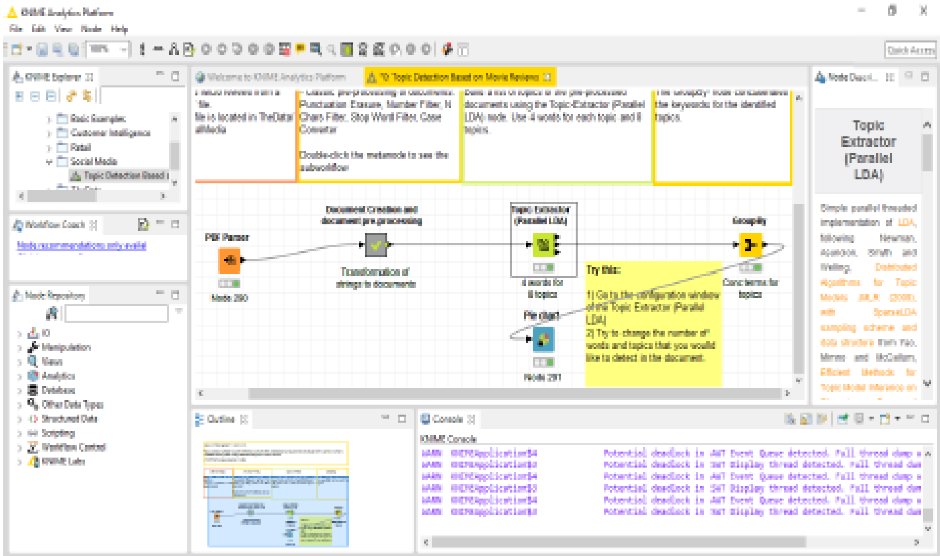

Fig. 5.1, KNIME program

5.2.1 KNIME Components

KNIME consists of many modules in the node repository that can be used to process and analyze data. This analysis uses the four components shown in Figure 5.2: Document Creation and Document Correction, PDF Analyzer, Material Extractor (Parallel LDA), and GroupedBy.

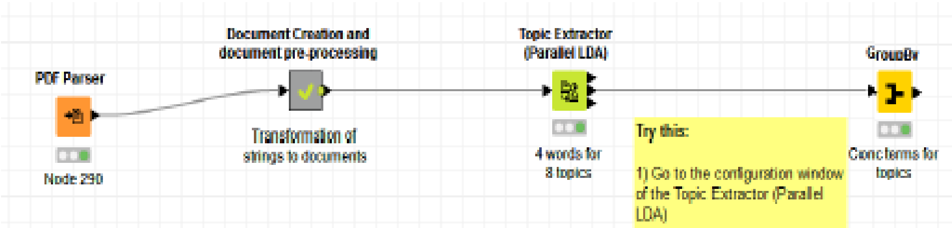

Fig. 5.2, KNIME components that are used in this thesis.

5.3 The Result Obtained from KNIME

We used the same 45 studies in the KNIME program record. Therefore, we set the number of words to 2 and topics to 3 to rise the possibility of discovering distinctive topics. The program returned a number of studies for each topic, the results came as following: In topic 0 there are 16 papers and two words (students and reading). In topic 1 there are 14 articles and two words (training and students). Topic 2 has 15 studies and two words (students and students) are included. After receiving these topics, we found for each topic standard deviation, the mean and standard error of the environment. The results of these statistics are shown in Figures 5.3-5.5.

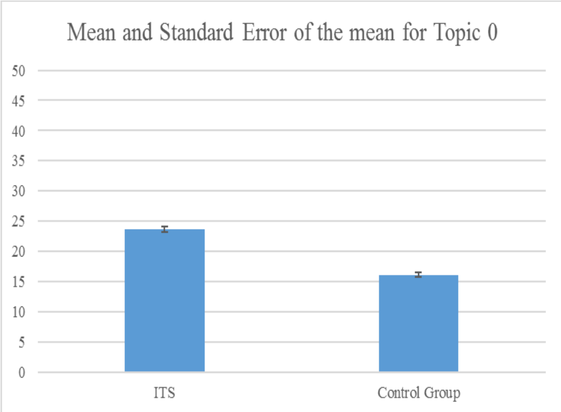

Fig. 5.3, The mean and the standard error of the mean for topic 0.

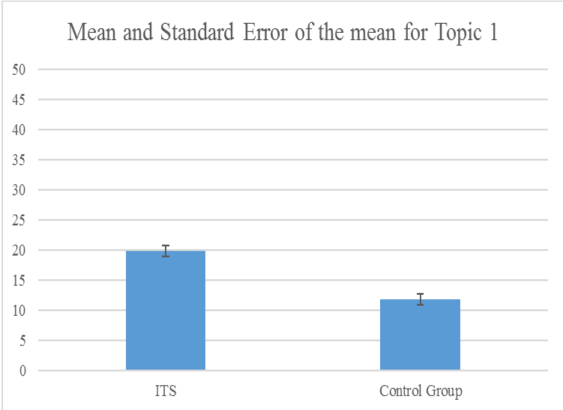

Fig. 5.4. The mean and the standard error of the mean for topic 1.

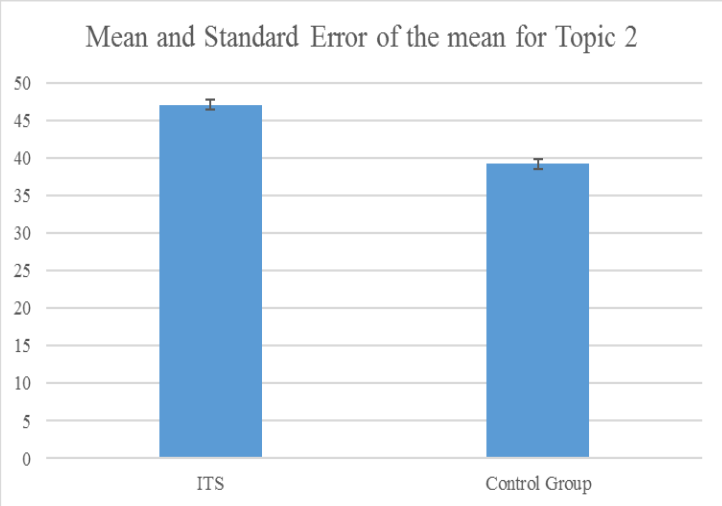

Fig. 5.5, The mean and the standard error of the mean for topic 2.

To analyze these results, we did the t-test for them, and then the ANOVA test. The obtained results of t-test are presented in Table 3 and ANOVA in Table 4.

Table 3. *T-test for the Topics*

The Topics	Statistical Significance
Topic 0	P<0.0001
Topic 1	P<0.0001
Topic 2	P<0.0001

Table 4. *ANOVA Test for the Topic*

The Topics	F-value	P-value
Topic 0	146.7	0.000
Topic 1	39.9	0.000
Topic 2	66.0	0.000

After running the KNIME program and getting the above results, we run the program again but we added the most two common words for each topic to the "stop list" so that KNIME would be forced to select the next two most common words for each topic. These words are:

Topic 0: (tutor and study).
Topic 1: (system and knowledge).
Topic 2: (tutoring and andes).

6.2 Conclusion

In summary, the studies reported in this article claimed that ITS could be used to help students develop more learning methods than traditional teaching methods. This document discusses basic information about the problems students face when using traditional teaching methods. To answer this question "Does the intelligent learning system develop opportunities for learners to learn more than traditional education?" ITS proposed to solve these problems. Then we defined the systematic review used in this study and provided a historical context for ITS. The researchers also explained the main components of the ITS and the protocol used to direct the analysis. Then, we presented the results of analyzes supporting the effectiveness of the ITS. Also, we presents the results obtained using KNIME and LDA that also support the effectiveness of the ITS on the students' learning.

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Appendix

Table 5, the studies that we used for this paper

Number of paper	The name of the paper
1.	Evaluating Student Learning Gains in Two Versions of AutoTutor.
2.	Evaluation of AnimalWatch: An intelligent tutoring system for arithmetic and fractions.
3.	Learning Linked Lists: Experiments with the iList System.
4.	Model-Based Reasoning for Domain Modeling in a Web-Based Intelligent Tutoring System to Help Students Learn to Debug C++ Programs.
5.	Teaching the Tacit Knowledge of Programming to Novices with Natural Language Tutoring.
6.	Teaching meta-cognitive skills: implementation and evaluation of a tutoring system to guide self-explanation while learning from examples.
7.	Exploring the Effectiveness of Knowledge Construction Dialogues.
8.	An Intelligent SQL Tutor on the Web.
9.	An Experimental Evaluation of Logiocando, an Intelligent Tutoring Hypermedia System.
10.	An intelligent tutoring system for the accounting cycle: Enhancing textbook homework with artificial intelligence.
11.	Evaluating an Intelligent Tutoring System for Design Patterns: the DEPTHS Experience.
12.	Evaluating the Effectiveness of the CPP-Tutor, an Intelligent Tutoring System for Students Learning to Program in C++.
13.	Controlled experiment replication in evaluation of e-learning system's educational influence.

14.	The Impact of a Peer-Learning Agent Based on Pair Programming in a Programming Course.
15.	An intelligent tutoring system that generates a natural language dialogue using dynamic multi-level planning.
16.	An experimental study of the effects of Cognitive Tutor Algebra I on student knowledge and attitude.
17.	An intelligent tutor for intrusion detection on computer systems.
18.	A Large-Scale Evaluation of an Intelligent Discovery World: Smithtown.
19.	Tutoring Bilingual Students with an Automated Reading Tutor That Listens: Results of a Two-Month Pilot Study.
20.	Intelligent Tutoring Goes to School in the Big City.
21.	Computer-Guided Oral Reading Versus Independent Practice: Comparison of Sustained Silent Reading to an Automated Reading Tutor that Listens.
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45.	Tutoring Bilingual Students with an Automated Reading Tutor that Listens.