Game-Based Learning: The Impact of Kahoot on a Higher Education Online Classroom

Khitam Altawalbeh[1*]

[1]Al-Balqa' Applied University, Jordan

Abstract—Digital games are an interactive tool within a multimedia education system and have the potential to make learning more effective and engaging, particularly for young students. The purpose of this investigation is to learn more about game-based learning. In this study, a game-based learning environment (Kahoot!) was used to improve motivation, fun, engagement, and utility for learning. The research was carried out in a university course to test the effectiveness of the proposed approach on students' learning. A total of 72 university undergraduates were purposively selected. A descriptive approach was used, and a survey was distributed to the learner. The study tool consisted of 26 items in four domains; fun, engagement, motivation, and utility for learning. The findings of the investigation revealed that fun, engagement, motivation, and utility for learning were supported by game-based learning. However, no significant differences were found based on gender, the field of study, and the academic year. Relied on the results a set of recommendations was proposed.

Keywords: Game-based learning, Kahoot, motivation, students' perspectives, higher education, online learning, educational technology

1. INTRODUCTION

The rapid advancement of digital technology has contributed positively to constructing an interactive learning environment in higher education. One of the educational games and game-based student response systems (GSRS) that can be used to support collaborative learning and discovery (Ebner & Holzinger 2007; Papastergiou 2009) is Kahoot. Kahoot (Kahoot!, Oslo, Norway) is a free game-based learning platform that the whole class can play at one time (Ebadi et al., 2021). As a GSRS (e.g., Gebbels, 2018; Plump & LaRosa, 2017), Kahoot can be leveraged to increase student engagement and learning through real-time quizzes (Shaker et al., 2021). Kahoot allows users to create questionnaires, provide a conversation platform, and create online exams to increase participation (Oblinger & Oblinger, 2017; Oktaviati & Jaharadak, 2018). Interestingly, Kahoot quizzes can be played both synchronously during live classes and asynchronously as assignments. Previous studies reported that Kahoot helps instructors to design courses that are engaging and fun; thereby increasing student curiosity and engagement (Chupradit et al., 2020; Dellos, 2015). In addition, Kahoot helps students retain material at a higher level (Baszuk & Heath, 2020). The increasing number of Kahoot users in the classroom because it allows students to answer questions instantly and get quick feedback (Plump & Larosa, 2017). Feedback informs the instructor which concepts students find difficult, so further discussion helps them think more deeply (Holbrey, 2020). Additionally, ease of use and accessibility have driven the adoption of Kahoot in the classroom (Donkin & Rasmussen, 2021).

Historically, Kahoot is the result of the Lecture Quiz research project which was started at the Norwegian University of Science and Technology in 2006 (Wang et al.,

2007). Kahoot allows teachers to easily create, share game screens, and play quizzes in class. As an online formative digital assessment tool based on mobile games, Kahoot is supported by mobile devices such as smartphones, tablets, or laptops. It can be accessed on any digital device that has an internet signal without space and time restrictions (Elkhamsy & Wassef, 2021). Kahoot allows users to create quizzes including adding images and videos to questions. Apart from that, Kahoot has game elements, such as point scoring, animations, music, timers, and leaderboards. Unlike other traditional SRS, Kahoot also offers a competitive environment by providing time limits and scoring for its quizzes. Students collect points based on their speed in providing correct answers (Felszeghy et al., 2019; Basuki et al., 2019). In each quiz, a bar graph showing how many students chose each given answer is presented (Aktekin et al., 2018). At the end of each game, the top three players are announced (Wang & Tahir, 2020). These conditions help students maintain their engagement (Wang, 2015) and increase class dynamics (Licorish et al., 2018).

Previous literature has documented the effect of using Kahoot on student performance at various levels of education. For example, Iwamoto et al. (2017) report that Kahoot has the potential to increase high-risk test scores among college and university-level students. Then, Wang (2015) reported that students who did Kahoot learned more and were more motivated than students who did paper quizzes. Furthermore, Chaiyo and Nokham (2017) found that Kahoot supports learning and increases student concentration, engagement, and motivation. Similarly, Zarzycka-Piskorz (2016) shows that the majority of students think that learning to use Kahoot is more effective and fun than traditional methods. Gebbels (2018) also reported that Kahoot was effective in promoting students' conceptual understanding and learning, and had a positive influence on their self-confidence. In other words, game-based learning, for example, Kahoot, is an effective learning tool because it uses attractive graphic and audio user interfaces to increase students' attention and participation (Wang, 2015; Woo, 2014).

To the best of our knowledge, there are no articles exploring students' perceptions of the use of Kahoot on learning in universities. Higher education students were chosen since all students had cellphones, whereas school children are not permitted to use cellphones at school. Since Kahoot is a relatively new web-based digital-learning game, empirical studies on student perceptions of its use in the classroom are still limited. Thus, the current study surveys students at a university who use Kahoot for their learning (i.e., fun, engagement, motivation, and utility for learning). In this survey, students' perceptions were analyzed based on several factors including gender, college, and academic year.

The purpose of this study is to investigate the impact of using Kahoot as a game in non-game context learning from the perspectives of undergraduates at the University of Jordan. Specifically, we wanted to investigate how Kahoot affects fun, engagement, motivation, and utility for learning from the perspectives of the student, and assisting students in achieving the desired learning goals, particularly when teaching and learning remotely.

1.1. Theoretical Framework and Literature Review
The lecture quiz research project, which was started in 2006 at the Norwegian University of Technology and Science (NTNU) produced the innovative game Kahoot. It is a platform for learning through games that are open to enable all types of learning enjoyable it may be used with any language and a wide variety of digital gadgets. The

Kahoot! additionally be set up to accommodate all individuals' ages. The platform facilitates teacher-learner varied interactions in school situations sizes via contests of learning utilizing the infrastructure already in place (which incorporate a strong Internet connection. The audio and graphical interfaces are integrated. A game experience has certain components that can perhaps increase motivation among learners, especially senior learners (Lin et al., 2018).

According to a sociocultural perspective on game-based learning, learning is socially created and motivated. This viewpoint also considers the platform for social engagement and contexts that games can give when social interactions occur, as well as the extent to which these interactions might improve learning (Plass et al., 2015).

The adoption of gamified applications is owing to its theoretical ability to utilize games' motivational value. The self-determination theory is the most prominent one associated with motivation. While Bandura's Self-Efficacy Theory or the Goal Setting Theory, take into account extrinsic motivation, self-determination theory (SDT) includes a more complete and holistic approach, including both intrinsic and extrinsic motivations and their links. SDT relies on three fundamental psychological needs that all people have and attempts to meet: relatedness, autonomy, and competence. These requirements are linked and boost intrinsic motivations, or doing basically because of pleasure and excitement, as well as extrinsic motivation, or behaving based on a prize or encouragement (Ryan & Deci, 2000)

Game-based learning is a subject of study that has gotten a lot of interest in recent years. Sabandar et al., (2018) declared that one of the easiest game-based learning platforms for instructors and students is Kahoot! Using this software has various clear benefits, particularly for academics, including free Kahoot creation, gameplay, and distribution are all free. The program adapts to a variety of learning contexts with ease. It offers a stimulating and difficult technique to get today's students interested in studying; the quiz game may be played both independently and in groups.

Kahoot a game-based learning platform, was unveiled in September 2013. The platform has to be simple for teachers to produce their material, conduct quizzes, and grade their students, as well as for students to join without creating an account, play without humiliation (confidentially), have pleasure, compete, and educate (Wang, 2015). Researchers have undertaken numerous studies on the impact of using the game-based learning platform in the classroom.

Erhel & Jamet (2013) examined the effects of two different types of instructions, they were able to determine the circumstances under which digital game-based learning is most efficient in the first experiment (learning instruction vs. entertainment instruction). The learning instruction generated deeper learning than the entertainment instruction, with no negative influence on motivation. The second experiment demonstrated that entertaining training leads to deep learning when learners are provided regular feedback on their performance. These two studies show that a serious game environment can help learners learn and stay motivated if it incorporates characteristics that encourage them to properly digest instructional content.

In All et al. (2014) study, it takes the first step forwards by outlining the current methodologies for evaluating the efficacy of DGBL. The findings revealed that due to the variability in inadequate study designs, comparing data across studies and thus looking at the efficacy of game-based learning on a broader level is currently difficult. The use of different statistical techniques for analyzing learning outcomes is related to three issues: different activities that are executed in the control groups, varying measures for assessing the effectiveness of DGBL, and the use of different statistical methods for

analyzing learning outcomes. Variables might cause study data to be muddled, resulting in inappropriate study designs. Components that are introduced to the game as part of the teaching approach (e.g., mandatory reading, debriefing) have been identified as possible confounds in this study.

Serrano (2019) investigated the impact of game-based learning on students. The impact of digital game-based learning on student learning at the K-12 level was investigated. Between 2011 and 2019, 16 peer-reviewed research studies, two meta-analysis studies, and two literature reviews were chosen for the study. According to the research, when digital game-based learning is combined with important game design aspects (collaboration, choice, and feedback) as well as instructional design, participation is often higher. According to research, digital game-based learning combined with cooperation can significantly increase student motivation; however, the inclusion of commands and feedback had no such effect. Individual research on digital game-based learning identified a considerable beneficial influence on student accomplishment, but one of two meta-analysis studies discovered a small positive impact on student achievement.

Putu Ade Resmayania & Nyoman Tri Darma Putrab (2020) conducted a study to discuss how to use Kahoot! to deliver the first meeting of an English class at the higher education level. One hundred twenty-five Mataram Tourism Institute freshmen in Indonesia were exposed to, evaluated, and questioned on the usage of Kahoot! as a teaching platform to provide the course overview at the start of class. This activity includes a total of twenty questions. The learners responded positively to Kahoot, and it appears that it will achieve all of the first-class introductory objectives with ease. Despite several shortcomings in this gamification, more meaningful contact amongst students, more awareness of course topics, and increased motivation were seen.

Another study was done by Cárdenas-Moncada et al. (2020) which determined the impact of Kahoot on students in a Chilean vocational higher-education classroom. A quasi-experimental study was set up. A survey was also administered to explore students' perceptions of and attitudes towards the use of Kahoot in the classroom. The results showed a statistically significant difference in scores of a low-stakes test for students who used Kahoot versus students who did not. Moreover, the results from the survey indicated that students' perceptions of and attitudes towards the use of Kahoot were found to be highly positive, which contributed to creating a better classroom environment and fostered better academic performance.

Hartt et al. (2020) study investigated the usefulness of game-based learning in planning education. It looks at how gamification affects planning students' perceptions of learning, engagement, and teamwork. Two distinct teaching strategies were used to present two sessions in an undergraduate planning course (one traditional lecture-style, one game-based). An online questionnaire and semi-structured interviews were used to collect feedback. Students preferred and were more involved in the game-based lecture, according to the findings. Finally, the study asserted that gamification is best suited for the education system.

Hussein et al. (2021) provided evidence on the effectiveness of game-based learning applications in K-12 mathematics instruction. Between 2008 and 2019, 43 publications were assessed in the Web of Science's Social Sciences Citation Index (SSCI) and other top-ranked educational technology journals. The findings were then categorized into three primary categories based on the multi-dimensional framework: information acquisition, perceptual and cognitive skills, and affective, motivational, and behavioral transformation. The survey also discovered that a significant proportion of

DGBL apps were built around a certain design aspect or learning principle. In addition, this study listed some gaps in the literature in this field, indicating that more research is needed to understand how different dynamics (e.g., collaborative/ cooperative, competitive) influence students' learning.

Based on the previous studies, it is obvious that most studies used game-based learning to investigate its impact on student's performance, achievement, and motivation (Erhel & Jamet, 2013; Serrano, 2019; Hartt et al., 2020), while Cardenas (2020) and Putu Ade Resmayania & Nyoman Tri Darma Putrab (2020) used Kahoot, particularly as a game-based learning tool, as the current study. In contrast, this study investigated using Kahoot in higher education in Jordan where no similar studies have been done.

1.1.1. Significance of the study
- Researchers and educators interested in using educational computer games to teach may find the results of this study useful. Gains across all areas, with the more preferred comparative methodology being the conventional educational approach.
- Providing a thorough grasp of the impact that digital game-based learning has on higher education learning outcomes when integrated into a university course or program.
- The research also included a tool that had been designed and validated for validity and reliability, which may be valuable for educational organizations working on game-based learning.

1.1.2. Study questions
- What is the impact of Kahoot on students' learning (fun, engagement, motivation, and utility for learning?
- Are there any significant statistical differences in the impact of Kahoot on learning based on: gender, college, or academic year?

2. METHODS

The present study used a survey descriptive method, in which survey was used to gather the required information to evaluate the study's queries. A total of 72 students between the ages of 19-21 years (51 females and 21 males), from scientific and humanities colleges, were randomly recruited from the University of Jordan for this study.

The educator generated Kahoot online quizzes, and administrated synchronizely during remote learning and teaching in the teaching skills and research skills course, following the completion of each unit. The game was used in a teaching environment. The technique, goal, and directions for using the Kahoot platform were delivered by the instructor. Each Kahoot quiz consists of 10-15 multiple-choice questions and each question is timed 10-20 seconds maximum. After completion of the quiz, the top Kahoot three winners get a special certificate. Participants took part in a lectured online course for ten weeks and then engaged at the end of each unit in digital game-based learning; Kahoot.

The study aims to examine the impact of Kahoot on learning. To achieve this objective, the study followed a quantitative approach. The researchers designed a 26-item questionnaire to collect the data. The questionnaire was sent to the sample using an online form that was circulated among the respondents. We asked the students to

rate how much they agreed or disagreed with the statements on a scale of one to four ranging from strongly disagree to strongly agree (see Table 1).

Table 1. The Criteria Used for the Classification of Means

Level	Range	Level	Impact
Strongly disagree	1-1.75	Very low	1 to 2.51; negative impact
Disagree	1.76-2.51	Low	
Agree	2.52-3.27	High	More than 2.51; positive impact
Strongly agree	>3.27	Very high	

The questionnaire consists of four sections; the first is fun, the second is engagement, the third is motivation, and the last is a utility for learning (see Table 2). Students' perceptions and opinions toward Kahoot sessions were obtained using an online questionnaire to assess the usefulness of games in the classroom. A quantitative framework was supplied by the questionnaire. The evaluation was completed after lectures to gain a better grasp of how the participants contrasted the lectures after being exposed to online learning by teams.

Table 2. The Items that Represent the Four Domains of the Questionnaire

Domain	Items Number	Number of Items
Fun	1-7	7
Engagement	8-11	4
Motivation	12-15	4
Utility for learning	16-26	11
Total		26

Table 3. Demographic Characteristics of the Participants

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	51	70.8	70.8	70.8
Male	21	29.2	29.2	100.0
Total	72	100.0	100.0	
Academic Year	3	21	29.2	29.2
	2	48	66.7	95.8
	4	3	4.2	100.0
	Total	72	100.0	
Field of study	Humanities	41	56.9	56.9
	Scientific	31	43.1	100.0
	Total	72	100.0	

Table 3 shows the majority of the participants are female (70.8%) and (29.2%) accounted for males. More than half of them are second year (66.7%), while (29.2%) of the sample are in their third year, whereas (4.2%) of the students were in their fourth year. Also, the percentage of students in humanities colleges was (56.9%) of the overall sample, while (43.1%)of the sample were students in scientific colleges.

2.1 Study Tool

A survey was implemented in the current study to assess the impact of Kahoot on learning. It consisted of two sections the first is demographic information about the respondents (gender, academic year, and field of study), and the second section is the questionnaire including 26 questions, in four domains as in Table 2.

2.2 Validity and Reliability

To guarantee the tool's validity, it was shown to professionals in the field of expertise, which is one of the most efficient tools to do so, and they offered textual input. After the inclusion, elimination, and change of various paragraphs, the tool was still valid. As a result, the tool's final version includes (26) surveys. Cronbach alpha was calculated for the survey as confirmation of the constructs' inbuilt consistency and reliability Table 4. The overall instrument's Cronbach alpha is 0.96, which means the instrument is reliable and accepted for this study.

Table 4. Reliability Coefficients of Research Instrument

Domain	Cronbach Alpha Coefficients
Fun	0.94
Engagement	0.84
Motivation	0.79
Utility for Learning	0.93

2.3 Data Analysis

In this study, SPSS is used for quantitative data analysis. Descriptive statistics including percentage, mean, and standard deviation were calculated. Analyzes of variance (ANOVA) were applied to compare the mean significant scores obtained by students by college and academic year. The level of significance was set at 0.05.

3. RESULTS

3.1 The Results and Discussion of the First Question

What is the impact of Kahoot on students' learning (fun, engagement, motivation, and utility for learning? To evaluate the results of the application of Kahoot in the classroom, after this learning experience an online survey was conducted on the students. Eighty-two (82) students participated, and 72 students fully completed the questionnaire for a response rate of 87.8%. The quiz was seen by students as a type of revision that allows them to reflect on the lecture content that they had learned. This survey allows us to assess Kahoot's educational impact (see Table 5).

Table 5. I Have Previous Experience with Kahoot

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	44	61.1	61.1	61.1
	Yes	28	38.9	38.9	100.0
	Total	72	100.0	100.0	

Table 5 shows that the majority of respondents (61.1%) admitted that before enrolling in the course, they had never used Kahoot! or had any other engagement with it. About (38.9) percent of those surveyed said they have used Kahoot! before.

Table 6. Means and Standard Deviations of the Perceptions of Using Game-based Learning/Kahoot

Item	SD F (%)	D F %	A F %	SA F %	Mean	SD	Level
I looked forward to playing Kahoot	3 4.2%	7 9.7%	20 27.8	42 58.3%	3.403	.8335	Very High
I felt excited when playing Kahoot	3 4.2%	8 11.1%	18 25.0%	43 59.7%	3.403	.8502	Very High
It was easy to use Kahoot	3 4.2%	10 13.9%	17 23.6%	42 58.3%	3.361	.8770	Very High
I found Kahoot fun	4 5.6%	4 5.6%	14 19.4%	50 69.4%	3.528	.8387	Very High
I enjoyed playing Kahoot	2 2.8%	4 5.6%	23 31.9%	43 59.7%	3.486	.7314	Very High
I felt positive when playing Kahoot	2 2.8%	7 9.7%	19 26.4%	44 61.1%	3.458	.7861	Very High
I liked the competitiveness in our Kahoot sessions	2 2.8%	6 8.3%	13 18.1%	51 70.8%	3.569	.7659	Very High
I responded as accurately as possible to each item or question in each Kahoot session	5 6.9%	3 4.2%	24 33.3%	40 55.6%	3.375	.8630	Very High
I responded as quickly as possible to each item or question in each Kahoot session	3 4.2%	4 5.6%	27 37.5%	38 52.8%	3.389	.7792	Very High
I focused on the ítems or questions in each Kahoot session	2 2.8%	8 11.1%	25 34.7%	37 51.4%	3.347	.7901	Very High
I responded to each item or question in each Kahoot session	6 8.3%	12 16.7%	20 27.8%	34 47.2%	3.139	.9830	High
I did the Kahoot quizzes not only because the teacher requested it	7 9.7%	3 4.2%	23 31.9%	39 54.2%	3.306	.9441	Very High
I wished to do better in the Kahoot sessions than most other students in the class	2 2.8%	8 11.1%	18 25.0%	44 61.1%	3.444	.8030	Very High
I was eager to learn via Kahoot	6 8.3%	5 6.9%	21 29.2%	40 55.6%	3.319	.9319	Very High
I was motivated by the prospect of winning in these Kahoot sessions	4 5.6%	15 20.8%	20 27.8%	33 45.8%	3.139	.9391	High

Item	SD F (%)	D F %	A F %	SA F %	Mean	SD	Level
I wish Kahoot was also used in other subjects	4 5.6%	5 6.9%	16 22.2%	47 65.3%	3.472	.8553	Very High
Kahoot helped me to retain my new knowledge	4 5.6%	4 5.6%	21 29.2%	43 59.7%	3.431	.8363	Very High
Kahoot enhanced my understanding of the subjects	2 2.8%	8 11.1%	22 30.6%	40 55.6%	3.389	.7971	Very High
Kahoot was an effective method to correct my misconceptions about the subjects	3 4.2%	9 12.5%	23 31.9%	37 51.4%	3.306	.8498	Very High
Kahoot motivated me to learn more	3 4.2%	7 9.7%	29 40.3%	33 45.8%	3.278	.8088	Very High
Kahoot was a distraction to the real class activities	23 31.9%	13 18.1%	16 22.2%	20 27.8%	2.458	1.2096	Low
Kahoot was an effective method for reflective learning	4 5.6%	6 8.3%	27 37.5%	35 48.6%	3.292	.8465	Very High
Kahoot helped me reinforce my learning	3 4.2%	8 11.1%	23 31.9%	38 52.8%	3.333	.8392	Very High
Kahoot facilitated my learning of the subjects	3 4.2%	4 5.6%	26 36.1%	39 54.2%	3.403	.7811	Very High
Kahoot helped me being prepared for my test	5 6.9%	9 12.5%	21 29.2%	37 51.4%	3.250	.9307	High
Kahoot was an effective method to provide feedback	1 1.4%	6 8.3%	19 26.4%	46 63.9%	3.528	.7115	Very High
Total					3.3396	.61816	

Table 6 shows that the total mean is (3.34) which indicates a high level of perceptions toward Kahoot learning. The mean score of these items ranges from (3.14-3.56), as revealed in the table three items (11, 15, 25) were high level, and twenty-two items were very high levels of agreement in using game-based learning. Item 7 was the highest "*I liked the competitiveness in our Kahoot sessions*", followed by item 26 and item number 4 "*Kahoot was an effective method to provide feedback*", "*I found Kahoot fun*", in the third place item 5 "*I enjoyed playing Kahoot*". While the lowest item (11, 15) was "*I responded to each item or question in each Kahoot session*" and "*I was motivated by the prospect of winning in these Kahoot sessions*" respectively, where the means were (3.14). whereas no item obtained a low level from the point of view of respondents excluding one item (item 21) that says "*Kahoot was a distraction to the real class activities*". The means and Standard deviations for four Domains (Fun, Engagement, Motivation, and utility for Learning) were calculated and presented in Table 7.

Table 7 shows that the highest mean reward for fun (3.4583), the second for engagement (3.3125), followed by Motivation (3.30), and the least for utility for learning (3.29). The four results show a high level of acceptance. Showed that positive impact regarding the four domains.

Table 7. Descriptive Statistics for the Four Domains (Fun, Engagement, Motivation, and Utility for Learning)

Domain	N	Mean	SD
Fun	72	3.4583	.69405
Engagement	72	3.3125	.70305
Motivation	72	3.3021	.70951
Utility for learning	72	3.2854	.65933
Total mean	72	3.3396	.61816
Valid N (listwise)	72		

These experiences, according to the learners participating, have allowed them to have fun (88.8% agreed that they have fun), enhance engagement and motivation, and improve utility for learning. And these results are in line with the study by (Erhel & Jamet, 2013; Stefanie Vásquez et al., 2017; Serrano, 2019) that asserted GBL has motivated students in terms of concrete learning experiences in the classroom. Game-based learning is a fun learning environment, since it has music, and sound effects, and each question is time-limited. Students also stated that quizzes allowed them to be active participants while having fun during the learning process, which drove them to be more prepared for another meeting and to study in a fun way, as illustrated in the following extract "*I am looking forward to playing Kahoot and to be the winner in this game*".

Another student stated that "*I wish all other courses implement Kahoot, at least we are not getting bored and having fun while learning*".

"*Thank you Doctor for the way you are teaching, in the final exam I remembered the right answer from Kahoot quizzes*", one of the students' comments.

Besides most of them expressed their happiness to have this game. Furthermore, they stated that the Kahoot! sessions promoted due to the prizes awarded to the top after each session. It can be noted from Table 6 that almost (74%) were motivated to be the winners, moreover very high percentage (95.9%) of the participants were very competitive in doing quizzes. And these results go in line with results in (Ismail et al., 2019) in which every learner participates in the activity, and game-based learning is an amusement of some type. The technology was also regarded as demanding, with the ability to stimulate education through the utilization of audio-visual stimuli. The game-based learning components in Kahoot! were noted by the participants and encouraged learning to be enjoyable.

Sabandar, Supit and Suryana (2018) claimed that for decades, educational games have been utilized as a supplement to regular lectures to promote education. According to Tom Malone's notion of intrinsically motivated guidance, learning is enjoyable when it falls into one of 4 classifications: Challenge (uncertainty in aims and consequences), Fantasy (fantasy that captivates, either intrinsically or extrinsically), and Curiosity (sensor curiosity through graphics and audio, and cognitive curiosity). (2015) (Lieberoth). Malone's idea from the 1980s still holds for today's teaching and learning processes, but the need for immediacy grows.

When taking a motivational perspective, proponents often argue that the most important benefit of games is to engage players in effortless learning by creating the right level of engagement, just between boredom and frustration. In addition, because of the certificates offered to the winners at the end of each game, participation was promoted. So these kinds of interactions make learning easier. Plass et al. (2015) Stated that Game-Based Learning entails increasing user engagement on several levels (cognitive, affective, behavioral, and sociocultural), as well as putting a greater emphasis

on the user's experience. In game-based learning allows users to compare and observe how their peers are doing which enhances a kind of motivation. Nikolic, Nikolić, and Gajić (2022) added Practicing Kahoot has an impact on the dynamics of the classroom and increases students' motivation and openness to participate. Additionally, it has been demonstrated to be particularly effective in online environments, as ordinary classrooms are progressively being replaced with online learning as a result of the COVID-19 epidemic.

Furthermore, earning points and striving to be in the top five on the leaderboard adds excitement and motivation to the gameplay. According to a course evaluation in which Kahoot! was used, students stated that Kahoot! is a far superior option to conventional classroom exercises. The ability to enjoy a game during a class is seen as a nice diversion from other forms of learning, in which it keeps the students' attention up, and students study through game activities, they are less bored, which increases their enthusiasm to learn.

For utility for learning, Kahoot allows users to pick from a variety of alternatives to attain a certain objective. And that is asserted by Kolb (2014) in which knowledge is learned essentially via individual and situational experiences rather than teaching, according to constructivist learning theory and the sociocultural theory of cognitive development. Moreover, (Figley et al., 2015) claimed that because of the lengthy connection and play with the games, digital gaming technology allows teachers to track students' development over time. Digital games must be aligned with the learning content and goals to be efficient at the university level.

Kahoot can improve learning since the quizzes are built keeping in mind the intended learning outcoms. Game-based learning is based on constructivist learning principles. Which means that constructivism advocates providing students with the tools they need to create their own methods for issue solving. This indicates a collaborative process in which learners engage with their surroundings to tackle the problem that has been assigned to them. As Table 6 shows (84.8%) of the learners were eager to learn via Kahoot. Also, (84.7%) asserted that Kahoot facilitated learning on the subjects. And (89.4%) claimed that Kahoot helped them to retain new knowledge, while (86.2%) stated that Kahoot enhanced their understanding of the subjects. (86.1%) agreed Kahoot was an effective method for reflective learning. A similar trend of (90.3%) agreement was discovered for items 24 and 26 in which the students declared that Kahoot facilitated learning on the subjects, and Kahoot was an effective method to provide feedback. Furthermore, the students were grateful for the synchronous administration of Kahoot quizzes since it forced them to plan for lectures by pre-reading before the start of lecture sessions, and they improved their attentiveness throughout lectures, having in mind that each lecture will end with a quiz.

Likewise, the study found that using Kahoot! with audio and points has a significant (large effect size) impact on students' concentration, engagement, enjoyment, motivation, perceived learning, and classroom dynamics and that using Kahoot with audio and points has a significant (large effect size) impact on students' concentration, engagement, enjoyment, motivation, perceived learning, and classroom dynamics. Of worst outcome was when there were no marks and no audio (Wang, & Lieberoth, 2016). In Kahoot!, the classroom is briefly turned into a game show, with the instructor serving as the presenter and the participants serving as contestants. This dream is strengthened by audio and images, as well as points, scoreboards, and a podium, all of which should contribute to a positive and enjoyable learning experience. According to several studies, game show elements such as graphics, points, and soundtrack help to create a more

favorable learning atmosphere (Aktekin et al., 2018; Baydas & Cicek, 2019). Sabandar et al. (2018) affirmed that on a more practical level, the utilization of Kahoot can assist students in achieving their desired learning outcomes, as well as increase their motivation and engagement while learning in a fun way.

As can be ascertained in the results, Students who took part in this learning experience often believe that the game helps them achieve higher learning outcomes. The findings demonstrated that Kahoot plays a significant role in enhancing students because it stimulates fun, engagement, motivation, and utility for learning. Since this game accurately reflects actuality, the game's choice was remarkably efficient. As a result, we were able to achieve superior results, as evidenced by the student's responses to the survey. These results are in agreement with the results of (Ismail et al., 2019; Mdlalose et al.,2021). Every single player had a positive attitude about the game as confirmed by (Sabandar et al., 2018).

3.2 Results of the Second Question

The second question is: "*Are there any significant statistical differences in the impact of Kahoot on learning based on: gender, colleges, or academic year?*"

RQ.2.1. Are there any statistically significant differences between the means related to gender? To answer the question means and standard deviations were calculated (Table 8).

Table 8. Means and Standard Deviations and Significance of Four Domains (Fun, Engagement, Motivation, and Utility for Learning based on Gender)

Gender		Fun	Engagement	Motivation	Utility for Learning
Female	Mean	3.5434	3.3088	3.3137	3.3102
	N	51	51	51	51
	SD	.59179	.60948	.57411	.57444
Male	Mean	3.2517	3.3214	3.2738	3.2251
	N	21	21	21	21
	SD	.87820	.90879	.98077	.84434
Total	Mean	3.4583	3.3125	3.3021	3.2854
	N	72	72	72	72
	SD	.69405	.70305	.70951	.65933
	Sig.	.105	.945	.830	.622

Table 8 shows that there is no significant difference between the means based on gender since the sig is more than 0.05; (0.105, 0.945, 0.830, 0.622) for the four domains fun, engagement, motivation, and utility for learning respectively. This outcome may be attributed to the fact that all students, regardless of gender, are persuaded of the practicality of these recent technologies and game-based, as well as their search for renewal and growth away from stereotypes and conventional ways.

RQ.2.2. Is there any statistical difference between the means based on the field of study? To answer this question means, the standard deviation is calculated, and the ANOVA test is in Table 9.

Table 9 shows that there is no significant difference between the means based on the field of study since the sig is more than 0.05; (0.272, 0.660, 0.380, 0.206) for the four domains fun, engagement, motivation, and utility for learning respectively. These

findings may be explained by the fact that students, regardless of the subject of study, prefer game-based learning over monotonous teaching methods because it sets the students at the center of the learning process and takes into account this generation's interest in electronic games.

Table 9. Means and Standard Deviations and Significance of the Four Domains (Fun, Engagement, Motivation, and Utility for Learning based on Field of Study)

Field of Study		Fun	Engagement	Motivation	Utility for Learning
Humanities	Mean	3.3798	3.2805	3.2378	3.1996
	N	41	41	41	41
	SD	.70175	.77095	.76025	.72932
Scientific	Mean	3.5622	3.3548	3.3871	3.3988
	N	31	31	31	31
	SD	.68107	.61160	.63848	.54428
Total	Mean	3.4583	3.3125	3.3021	3.2854
	N	72	72	72	72
	SD	.69405	.70305	.70951	.65933
	Sig.	.272	.660	.380	.206

RQ.2.3. Are there any statistical differences between the means of the four domains based on the academic year?

To answer this question means, SD is calculated, and the ANOVA test is in Table 10.

Table 10. Means and Standard Deviations and Significance of the Four Domains (Fun, Engagement, Motivation, and Utility for Learning based on Academic Year)

Academic Year		Fun	Engagement	Motivation	Utility for Learning
3	Mean	3.2041	3.3095	3.1667	3.1385
	N	21	21	21	21
	SD	.78321	.80197	.84533	.90664
2	Mean	3.5744	3.3073	3.3750	3.3371
	N	48	48	48	48
	SD	.64529	.67878	.64205	.51833
4	Mean	3.3810	3.4167	3.0833	3.4848
	N	3	3	3	3
	SD	.41239	.52042	.80364	.74041
Total	Mean	3.4583	3.3125	3.3021	3.2854
	N	72	72	72	72
	SD	.69405	.70305	.70951	.65933
	Sig	.122	.967	.465	.453

Table 10 shows that no significant difference between the means based on the four domains since the significance is more than 0.05 for the four domains; (fun 0.122, engagement 0.967, motivation 0.465, and utility for learning 0.453).

4. DISCUSSION AND CONCLUSION

The current study has succeeded in investigating students' perspectives in using game-based learning specifically Kahoot in learning. The results revealed a high level of acceptance of using Kahoot in learning. These results are in agreement with (Sabandar

et al., 2018). No significant differences between the means were found based on gender, academic year, or field of study

This article has presented the effect of using Kahoot on students learning; specifically, fun, engagement, motivation, and utility for learning. Students are always willing to participate in novel learning situations, particularly when games are used as a teaching-learning tool. Although online game-based learning is not a new concept in education, it is becoming increasingly popular among educators, particularly as more school districts implement 1:1 technology projects. Educators are constantly seeking new approaches to using technology in their classrooms to benefit students. Digital game-based learning assists students in achieving learning objectives, and digital game-based learning is a popular option in teaching. This is especially true now that internet sites for digital-game-based learning are becoming more widely available. Educators strive to fulfill the requirements of learners who are struggling academically and those who require reinforcement daily. When selecting technology resources for students to use, such as digital game-based learning, instructors must establish whether learners will be highly engaged (Serrano, 2019), taking into consideration that digital games must be aligned with the course material and goals to be efficient at the higher education according to (Figley et al., 2015).

To enhance students' academic experience, educational affordances of game-based learning platforms such as Kahoot must be utilized as a technical approach that is required and appropriate for today's students. Game-based learning platforms, in particular, can be used to simplify abstract and theoretical subjects. While many digital platforms can be used to assess individuals, this needs extensive preparation and a clear understanding of how to use these tools. Using the pedagogical features of game-based learning platforms like Kahoot to support purposeful teaching and learning in higher education can be a game-changer.

Bulletin (2015) agrees, stating that the learning activities can be integrated into Kahoot! must be structured in such a way that students have opportunities to connect with their educators and teammates, as well as provide quick and relevant feedback throughout teaching sessions. However, organizations that want to use Kahoot for fun learning should keep in mind that the lessons should be well-planned to ensure that learners obtain the desired results and prevent too much fun, which might lead to a bad teaching atmosphere and harmful repercussions.

These results add to the expanding corpus of research on the merits of gamification by emphasizing its beneficial effects on learning (fun, engagement, motivation, and utility for learning). All these results strongly advocate incorporating Kahoot! into the teaching and learning processes in higher education courses. To sum up, the use of digital games in the classroom, as detailed in this study, has inspired students' knowledge of tangible learning experiences. We cannot pretend that our study is all-inclusive since just a limited number of students at one university in Jordan, which is the University of Jordan. And because this quantitative study was carried out at a single institution, caution should be taken when extrapolating the outcomes to other groups.

5. RECOMMENDATION AND FUTURE STUDIES

There is still more research to be done on digital game-based learning. Game-based learning research is still in its infancy, and as more study is conducted, more will be learned. There is also a necessity for greater research into the effects of instructional design and game design components on effective teaching. And the effect of Kahoot

on achievement/ performance. As a result, it is advised that these research issues be given in future empirical investigations. Based on the findings a set of recommendations is proposed:

- To build a new pedagogical paradigm, games should be included in the teaching process by teachers, and curriculum providers. As a result, consider the concept of enjoyable learning, which refers to learning that incorporates game elements even if the context isn't a game.
- Educational institutions must have a deeper grasp of the ideal conditions and procedures for students taking online courses to best suit their learning demands and behaviors.
- The application of these learning methods in play is an experience that academic institutions must foster. This must be accomplished through organizational programs that promote these encounters by making enough resources available.
- The usage of GBL should be increasingly prevalent among higher education lecturers, and digital game literacy for faculty members is needed.

6. REFERENCES

Aktekin, N. Ç., Çelebi, H., Aktekin, M., Aktekin, N. Ç., Çelebi, H., & Aktekin, M. (2018). Utilicemos Kahoot! Anatomía. *International Journal of Morphology*, *36*(2), 716–721. https://doi.org/10.4067/S0717-95022018000200716

All, A., Patricia, E., Castellar, N., & Looy, J. Van. (2014). Measuring Effectiveness in Digital Game-Based Learning: A Methodological Review. *International Journal of Serious Games*, *1*(2), 3–20. https://doi.org/10.17083/IJSG.V1I2.18

Anderson, B. O., Anderson, M. N., & Taylor, T. A. (2009). New territories in adult education: Game-based learning for adult learners. *In Research Conference*, *1*. https://digitalcommons.nl.edu/cgi/viewcontent.cgi?article=1000&context=ace _aerc#page=15

Basuki, Y., & Hidayati, Y. N. (2019). Kahoot! or Quizizz: The students' perspectives ELLIC. Proceedings of the 3rd English Language and Literature International Conference, ELLiC, 27th April 2019, Semarang, IndonesiaBaszuk, P. A., & Heath, M. L. (2020). Using Kahoot! to increase exam scores and engagement. *Journal of Education for Business, 95*(8), 548-552.

Baydas, O., & Cicek, M. (2019). Technology, Pedagogy, and Education The examination of the gamification process in undergraduate education: a scale development study. *Technology, Pedagogy and Education*, *28*(3), 269–285. https://doi.org/10.1080/1475939X.2019.1580609

Biggs, J., & Tang, C. (2011). *Teaching for Quality Learning at University Fourth Edition The Society for Research into Higher Education* (4th ed.). McGraw-Hill. www.openup.co.uk

Brom, C., Šisler, V., & R Slavík. (2010). Implementing digital game-based learning in schools: augmented learning environment of 'Europe 2045'. *Multimedia Systems*, *16*(1), 23–41. https://doi.org/10.1007/s00530-009-0174-0

Bulletin, K. J. (2015). Engaging and assessing students with technology: A review of Kahoot!. *Delta Kappa Gamma*, *81*(4), 89. https://search.proquest.com/openview/33d65e52a95d588daf56f7b5c6e8a406/ 1?pq-origsite=gscholar&cbl=47978

Cárdenas-Moncada, C., Véliz-Campos, M., & Véliz, L. (2020). Game-Based Student Response Systems: The Impact of Kahoot in a Chilean Vocational Higher Education EFL Classroom. *CALL-EJ*, *21*(1), 64–78.

Chaiyo, Y., & Nokham, R. (2017). The Effect of Kahoot, Quizizz and Google forms on the Student's Perception in the Classrooms Response System. *International Conference on Digital Arts, Media and Technology* (pp.178-182). IEEE.

Chupradit, S., Leewattana, A., & Chupradit, P. W. (2020). The correlation analysis of Internet usage and depression among undergraduate university students in Thailand: Cross-sectional study. *Journal of Advanced Research in Dynamical & Control Systems, 12*, 825–837.

Coffey, H. (2009). *Digital game-based learning.* Learn NC.

Dellos, R. (2015). Kahoot! A Digital Game Resource for Learning. *International Journal of Instructional Technology and Distance Learning, 12*(4), 49-52.

Dichev, C., & Dicheva, D. (2017). Gamifying education: what is known, what is believed and what remains uncertain: a critical review. *International Journal of Educational Technology in Higher Education*, *14*(1), 1–36. https://doi.org/10.1186/S41239-017-0042-5

Donkin, R., & Rasmussen, R. (2021). Student Perception and the Effectiveness of Kahoot!: A Scoping Review in Histology, Anatomy, and Medical Education. *Anatomical sciences education, 14*(5), 572–585. https://doi.org/10.1002/ase.2094

Ebadi, S., Rasouli, R., & Mohamadi, M. (2021). Exploring EFL learners' perspectives on using Kahoot as a game-based student response system. *Interactive Learning Environments*, 1–13. https://doi.org/10.1080/10494820.2021.1881798

Ebner, M, & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: an example from civil engineering. *Computers & Education, 49*(3), 873–890.

Elkhamisy, F. A. A., & Wassef, R. M. (2021). Innovating pathology learning via Kahoot! game-based tool: A quantitative study of students' perceptions and academic performance. *Alexandria Journal of Medicine, 57*(1), 215-223. https://doi.org/10.1080/20905068.2021.1954413

Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education*, *67*, 156–167. https://doi.org/10.1016/J.COMPEDU.2013.02.019

Felszeghy, S., Pasonen-Seppänen, S., Koskela, A., Nieminen, P., Härkönen, K., Paldanius, K. M. A., … Mahonen, A. (2019). Using online game-based platforms to improve student performance and engagement in histology teaching. *BMC Medical Education, 19*(1). https://doi.org/10.1186/s12909-019-1701-0.

Figley, C. R., Olt, J., Bressler, D., Moylan, G., Burgess, A. W., & Bernstein, M. (2015). Motivating game-based learning efforts in higher education. *International Journal of Distance Education Technologies*, *13*(2), 54–72. https://www.igi-global.com/article/motivating-game-based-learning-efforts-in-higher-education/128427

Gebbels, M. (2018). Re-engineering challenging and abstract topics using Kahoot! A student response system. *Compass: Journal of Learning and Teaching, 11*(2), 1-12. https://doi.org/10.21100/compass.v11i2.844

Hartt, M., Hosseini, H., & & M. M. (2020). Game on: Exploring the effectiveness of game-based learning. *Taylor & Francis*, *00*(5), 589–604. https://doi.org/10.1080/02697459.2020.1778859

Holbrey, C. E. (2020). Kahoot! Using a game-based approach to blended learning to support effective learning environments and student engagement in traditional lecture theatres. *Technology, Pedagogy and Education, 29*(2), 191–202. https://doi.org/10.1080/1475939x.2020.1737568

Hussein, M. H., Ow, S. H., Elaish, M. M., & Jensen, E. O. (2021). Digital game-based learning in K-12 mathematics education: a systematic literature review. *Education and Information Technologies*, *27*(2), 2859–2891. https://doi.org/10.1007/S10639-021-10721-X

Ismail, M. A. A., Ahmad, A., Mohammad, J. A. M., Fakri, N. M. R. M., Nor, M. Z. M., & Pa, M. N. M. (2019). Using Kahoot! as a formative assessment tool in medical education: A phenomenological study. *BMC Medical Education*, *19*(1), 1–8. https://doi.org/10.1186/S12909-019-1658-Z

Iwamoto, D. H., Hargis, J., Taitano, E. J., & Vuong, K. (2017). Analyzing the Efficacy of the Testing Effect Using Kahoot™ On Student Performance. *Turkish Online Journal of Distance Education, 18*(2), 1-14.

Kolb, D. (2014). *Experiential learning: Experience as the source of learning and development*. FT press. url: http://www.learningfromexperience.com/images/uploads/process-of-experiential-learning.pdf

Licorish, S. A., Owen, H. E., Daniel, B., & George, J. L. (2018). Students' perception of Kahoot!'s influence on teaching and learning. *Research and Practice in Technology Enhanced Learning, 13*(1). https://doi.org/10.1186/s41039-018-0078-8

Lin, D., Ganapathy, M., & Of, M. K. (2018). Kahoot! It: Gamification in higher education. *Pertanika Journal of Social Sciences and Humanities*, *26*(1), 565–582. http://www.pertanika.upm.edu.my/resources/files/Pertanika PAPERS/JSSH

Mdlalose, N., Ramaila, S., & Ramnarain, U. (2021). Using Kahoot! As A Formative Assessment Tool in Science Teacher Education. *International Journal of Higher Education*, *11*(2), 43. https://doi.org/10.5430/IJHE.V11N2P43

Nikolic, J. Nikolić, J., Gajić, T. (2022). The benefits of using Kahoot in conventional and online classrooms | Request PDF. *Conference: ELTA ConferenceAt: Singidunum University*.
https://www.researchgate.net/publication/360996644_The_benefits_of_using_Kahoot_in_conventional_and_online_classrooms

Oblinger, D. G., & Oblinger, J. L. (2017). Educating the net generation. *International Journal of Evaluation and Research in Education, 4*(1), 39–47.

Oktaviati, R., & Jaharadak, A. A. (2018). The impact of using gamification in learning computer science for students in university. *International Journal of Engineering and Technology, 7*(4), 121–125.

Papastergiou, M. (2009). Digital game-based learning in high school computer science education: impact on educational effectiveness and student motivation. *Computers & Education, 52*(1), 1–12.

Plass, J., Homer, B., & CK Kinzer. (2015). Foundations of game-based learning. *Taylor & Francis*283–258 ,(4)*50* ,. https://doi.org/10.1080/00461520.2015.1122533

Plump, C., & LaRosa, J. (2017). Using Kahoot! in the classroom to create engagement and active learning: A game-based technology solution for eLearning novices. *Management Teaching Review, 2*(2), 151–158. https://doi.org/10.1177/2379298116689783

Putu Ade Resmayania, N., & Nyoman Tri Darma Putrab, I. (2020). Gamification: Using Kahoot! to Make Students Love the Class from the Very Beginning. *Linguistics and ELT Journal, 7*(1), 10–18. https://doi.org/10.31764/LELTJ.V7I1.1649

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, *25*(1), 54–67. https://doi.org/10.1006/CEPS.1999.1020

Sabandar, G., Supit, N., & Suryana, E. (2018). Kahoot!: Bring the Fun Into the Classroom! *Indonesian Journal of Informatics Education*, *2*(2), 127–134. https://doi.org/10.20961/IJIE.V2I2.26244

Sabandar, G., Supit, N., & Suryana, E. (2018). Kahoot!: Bring the Fun Into the Classroom! *Indonesian Journal of Informatics Education*, *2*(2), 127–134. https://doi.org/httphttps://doi.org/10.20961/IJIE.V2I2.26244

Schunk, D. H., & DiBenedetto, M. K. (2016). Self-efficacy theory in education. In *In Handbook of motivation at school* (pp. 34–54). Routledge.

Serrano, K. (2019). The effect of digital game-based learning on student learning: A The effect of digital game-based learning on student learning: A literature review literature review. *Graduate Research Papers*, 943. https://scholarworks.uni.edu/grp/943

Shaker, A. J., Hurst, P. S., & Marshall, E. M. (2021). The effect of Kahoot on undergraduate student anxiety and confidence when studying statistics. *MSOR Connections, 19*(2), 41-54.

Snell, Y. (1999). Interactive lecturing: strategies for increasing participation in large group presentations. *Medical Teacher*, *21*(1), 37–42. https://www.tandfonline.com/doi/abs/10.1080/01421599980011

Stefanescu, C., Chirita, V., & … R. C. (2007). Network identity, the internet addiction and Romanian teenagers. *Proceedings of the 4th WSEAS/IASME International Conference on Engineering Education, Agios Nikolaos, Crete Island, Greece*, 206–210. https://www.academia.edu/download/52494546/563-125.pdf

Stefanie Vásquez, M., Peñafiel, M., Dario, A., Cevallos, C., Zaldumbide, J., Stefanie Vásquez, M., Cevallos, A., & Vásquez, D. (2017). Impact of game-based learning on students in higher education. *In Proceedings of the 9th Annual International Conference on Education and New Learning Technologies (EDULEARN), Barcelona, Spain*, 3–5. https://doi.org/10.21125/edulearn.2017.1942

Turner, P. E., Johnston, E., Kebritchi, M., Evans, S., & Heflich, D. A. (2018). Influence of online computer games on the academic achievement of nontraditional undergraduate students. *Taylor & Francis*1414–1410 ,(1)*5* ,. https://doi.org/10.1080/2331186X.2018.1437671

Wang, A. I., & Lieberoth, A. (2016). The effect of points and audio on concentration, engagement, enjoyment, learning, motivation, and classroom dynamics using Kahoot. *In European Conference on Games Based Learning (Vol. 20),Academic Conferences International Limited*, 738.

Wang, A. I. (2015). The wear out effect of a game-based student response system. *Computers & Education*, *82*, 217–227. https://doi.org/10.1016/j.compedu.2014.11.004

Wang, A. I., & Tahir, R. (2020). The effect of using Kahoot! for learning – A literature review. *Computers & Education, 149*, 103818. https://doi.org/10.1016/j.compedu.2020.103818

Wang, A. I., Ofsdal, T., & Morch-Storstein, O. K. (2007). Lecture quiz- a mobile game concept for lectures, in Proceedings of the IASTED International Conference on Software Engineering and Application (SEA 2007), Acta Press, Cambridge, MA, USA, 2007.

Woo, J. C. (2014). Digital Game-Based Learning Supports Student Motivation, Cognitive Success, and Performance Outcomes. *Educational Technology & Society, 17*(3), 291– 307.

Zarzycka-Piskorz, E. (2016). Kahoot it or not? Can games be motivating in learning grammar? *Teaching English with Technology, 16*(3), 17–36.

AUTHOR BIOGRAPHIES

Khitam ALTAWALBEH	PhD in Science Curriculum and Teaching Methods Al- Balqa' Applied University JORDAN Contact e-mail: altawalbehkhitam@gmail.com ORCID: https://orcid.org/0000-0002-2696-8672