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When Does Kahoot! Provide Most Value for Classroom Dynamics, Engagement, and Motivation?: IS Students' and Lecturers' Perceptions

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ABSTRACT

Game-based Student Response Systems (GSRSs) are held to improve students' motivation, engagement, classroom dynamics, academic performance, and enjoyment. Kahoot! is one such tool which is touted for its effectiveness at enhancing pedagogy. There is uncertainty, however, around the specific circumstances under which GSRSs provide value. We address this gap in this study by answering four research questions: (1) What are university students' sentiments around Kahoot!'s influence on class dynamics, engagement and motivation? (2) Are there differences in university students' sentiments towards Kahoot!'s use across different classes? (3) Are university students' sentiments expressed towards Kahoot!'s use associated with personal and academic factors? and (4) Under what specific circumstances does Kahoot! provide value? Sentiment and inductive analyses are used to extract the polarity of the opinions expressed by students in relation to Kahoot!'s use in three information science (IS) courses to identify clear themes around the circumstances where Kahoot! provides value. Findings show that university IS students perceive that Kahoot! has a positive effect on their motivation, engagement, and classroom dynamics. In addition, we established a relationship between the number of hours students dedicate to their studies and their positivity towards Kahoot!'s use. Weak evidence is also established to suggest that Kahoot! was more positively received by some students. Furthermore, Kahoot! provided value under all circumstances of use in the IS courses where it was employed. Educators may use Kahoot! or similar GSRSs for strategic advantage. They are advised, however, to pay special attention to the most disengaged students during lesson planning.

Keywords: Computing education, IS education, Student response systems, Game-based learning, Student perceptions, Computer-assisted education

1. INTRODUCTION

Students' motivation, engagement, and classroom dynamics are all factors which have been shown to improve the learning outcomes and academic achievement of students (Ames, 1992; Carini et al., 2006; Skinner & Belmont, 1993). Thus, it is critical for educators to construct learning environments that lead to improvements in these factors. In response to this, Game-based Student Response Systems (GSRSs) have been employed to improve the learning outcomes of students. GSRSs function on the principles of gamification, which involves the integration of game design elements in non-gaming systems (Deterding et al., 2011). The key benefit of utilizing gamification in an educational context is that it can effectively change students' attitudes towards learning (Kiryakova et al., 2014). This is most frequently achieved by incorporating game design elements, including "visual status, social engagement, freedom of choice, freedom to fail, and rapid feedback" (Dicheva et al., 2015).

These features promote excitement and lead to improvements in the motivation and engagement of students (Wang & Lieberoth, 2016), and the overall class dynamics. Educators often struggle with maintaining students' motivation and engagement (Lee & Hammer, 2011), particularly for situations where conventional lecture-style teaching is resented and perceived as "boring" (Cheong et al., 2013; Roehl et al., 2013). Furthermore, when looking at the Experiential Gaming Model (Kiili, 2005), we see that it is established that students learn through both direct experience and reflective observation, which lead to improved concentration and complete absorption in the task at hand (McCoy et al., 2016). These GSRSs are thus considered enablers of flow – i.e., they provide challenges, clear goals are set, quick feedback is provided, and an element of playfulness is present, thus leading to improvements in students' concentration and absorption (Kay & LeSage, 2009; Plump & LaRosa, 2017).

Kahoot!'s reported success as one of the popular GSRSs is widespread (Chaiyo & Nokham, 2017; Dellos, 2015; Graham, 2015; Ismail & Mohammad, 2017; Iwamoto et al., 2017; Licorish et al., 2018; Wang & Lieberoth, 2016; Yapıcı & Karakoyun, 2017; Zarzycka-Piskorz, 2016). There remains

doubt, however, around the specific cohort of students that perceive such a tool to be most beneficial and when the most value is provided. This insight is particularly needed at the tertiary level. While multiple studies have examined how university students respond to the use of Kahoot! (Bicen & Kocakoyun, 2018; Licorish et al., 2017; Plump & LaRosa, 2017), these works have not explored the specific circumstances under which Kahoot! provides value.

Kahoot! may support learning in some contexts, and particularly when university students are mature or where courses allow students to easily acquire subject knowledge (Sabourin et al., 2013; Zimmerman, 2002). In other situations, however, such a tool may not find favor with university students, for instance, when difficult course material is instructed or assessed (Méndez & Slisko, 2013). In fact, evidence reported for secondary school mathematics and science students confirms that Kahoot! was more favored during the teaching of boring mathematical concepts than science (Curto Prieto et al., 2019). This study thus sets out to determine how IS students respond to Kahoot!, and tests which factors (i.e., motivation, engagement, and class dynamics) are best/worst addressed by Kahoot!. In addition, the work under consideration examines how university students undertaking various IS courses perceive Kahoot!'s use. Through the use of inductive analyses, we then explain the specific circumstances for which Kahoot! provides value, covering: (1) how Kahoot! is effective, (2) why it is effective, and (3) how it could be more effective. Furthermore, this study serves to demonstrate the usefulness of sentiment analysis as an alternative, complementary, and most importantly, an objective tool for extracting sentiments from interview transcripts without the influence of the subjectivity of researchers, or having to rely on Likert-type responses which are often unsuitable for teasing out deeper meaning in respondents' comments.

The remaining sections of this paper are organized as follows. Section 2 provides the study background and lists the research questions. Section 3 presents the methodology while Section 4 provides the results. Section 5 discusses the findings and outlines implications. Section 6 concludes the work and proposes future research directions. Finally, we consider limitations to the work in Section 7.

2. BACKGROUND

2.1 Kahoot!

Kahoot! is a contemporary GSRS tool, allowing for informal assessments to be constructed whilst incorporating the principles of gamification (Kiryakova et al., 2014). The tool was released as a beta version in March 2013, where users connect to play games that are projected on a big screen via a PIN (refer to Kahoot! webpage here: https://kahoot.com/). This creates a "game-show" like environment (Wang, 2015) where educator-constructed quizzes are completed by students in an anonymous fashion. Students access Kahoot! via a web browser or app, where games are played as a part of formative assessment or as a break from the normal classroom activities. Ultimately, Kahoot! serves as an easy to use tool (Plump & LaRosa, 2017) that addresses issues of motivation and engagement (Barrio et al., 2016; Wang & Lieberoth, 2016), as well as classroom dynamics (Plump & LaRosa, 2017) through the inclusion of images, videos and audio, competition (in the form of points and a leaderboard), problem solving challenges, quick feedback (Plump & LaRosa, 2017), increased discussion (Méndez & Slisko, 2013), anonymity, and limited time requirements. In fact, the award of points may be customized, and when questions are answered in sequence, players gain more points for their winning streak. A final winners' board with animation is shown at the end of the game. Kahoot! games may be designed in the form of a puzzle, as multiple choice or true/false questions, punctuated with slides or videos, or as polls. They can be played in person or in virtual online sessions. This tool is now available in multiple languages (e.g., English, Spanish, French, Norwegian) with various pricing plans (e.g., starter, standard, presenter and pro), and can claim global reach, with reports of over one billion players and 40 million monthly active users reported in 2017 (see blog here: https://tech.eu/brief/kahoot-1-billion-players/). The features mentioned above are visualized in various Kahoot! interfaces in Figure 1.

2.2 GSRSs and Kahoot!

As noted in Section 1, GSRSs are founded on the mechanism of gamification or game principles in web-based technologies that support learning (Wang, 2015). Properties including real-time feedback, points rewarded for quick responses, leaderboard displays, suspenseful music, colorful displays, images, and video shows make GSRSs particularly attractive to students. These aspects are combined with standard quizzes and survey games in a web-based setting, where students become players and the educator acts as the host by controlling the pace of play (Ranieri et al., 2018; Wang & Tahir, 2020). Quiz or survey questions are asked sequentially, where students respond via their personal devices (e.g., mobile devices or laptops) and a summary of correct and incorrect answers are visualized (Limniou & Mansfield, 2019). Students are awarded points for answering questions correctly and efficiently within a given timeframe, and the scores of top students are shown on a leaderboard. These features promote excitement among students and a positive classroom environment (Plump & LaRosa, 2017; Wang, 2015). This is different to standard courseware (e.g., Blackboard and Desire2Learn), which have capabilities for doing quizzes but not the mechanism of gamification which converts the classroom into a gameshow (Licorish et al., 2017).

In terms of the study of GSRSs, and Kahoot! in particular, previous research conducted on the use of Kahoot! have primarily relied on Likert-type quantitative measures, although some qualitative studies have also been conducted, such as that of Licorish et al.'s (2018). Among these studies, Dellos (2015) reported that Kahoot! educators benefited from the quick feedback made available on student performance. They also noted that students were observed to become more curious and involved when they produced incorrect answers, and they felt more encouraged to research answers. Furthermore, the authors noted that when students created their own quizzes, they were encouraged to conduct research by themselves, aiding towards their learning and involvement. Zarzycka-Piskorz (2016) discovered in their study that Kahoot! was well-perceived by students taking a language course. In their study, they noted that 90% of the 112 students that participated perceived that they learned intended grammar structure directly as a result of the Kahoot! games. In addition, 70% of the students were motivated to learn grammar after playing Kahoot! and 90% found it enjoyable.

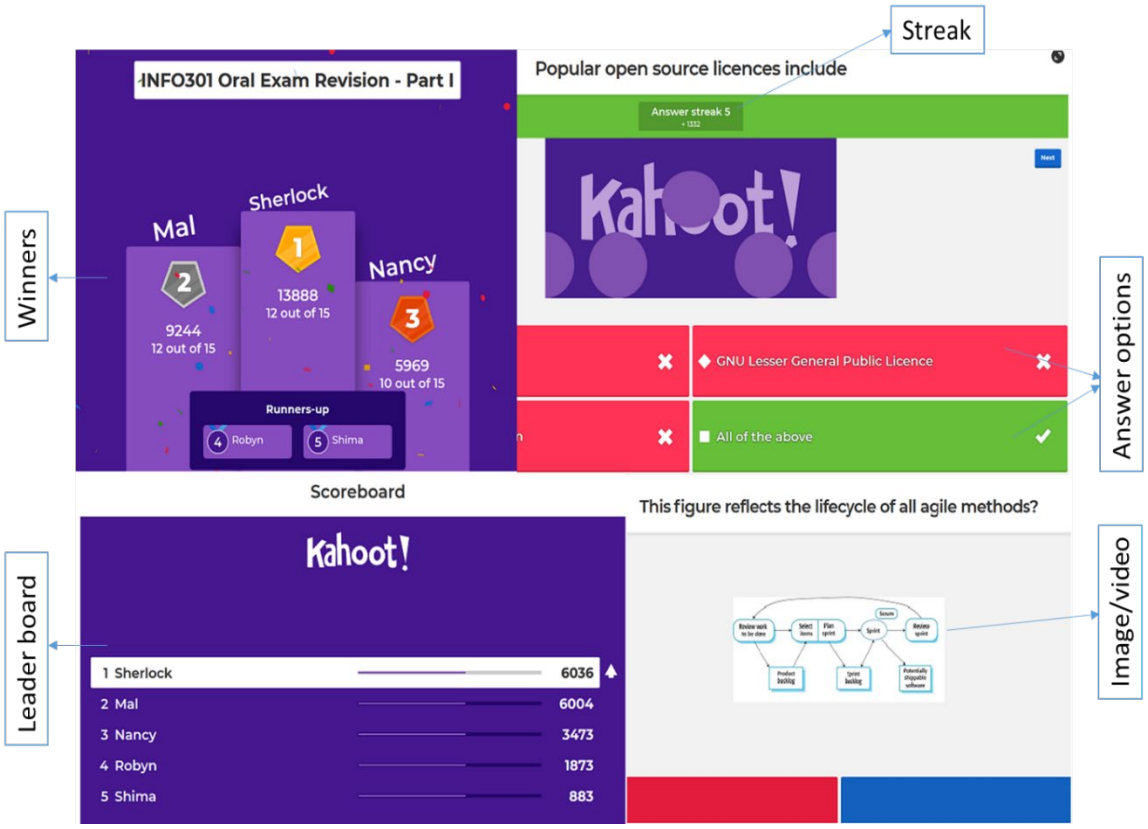

Figure 1. Various Kahoot! Interfaces

Wang and Tahir (2020) provide an analysis of 93 studies in their literature assessment on the effects of using Kahoot! to support teaching, and the main conclusion is that Kahoot! can have a positive effect on learning performance, classroom dynamics, students' and teachers' attitudes, and students' anxiety. In the body of evidence reviewed, Wang and Lieberoth (2016) researched the effects of Kahoot! (the elements of audio and points) on concentration, engagement, enjoyment, perceived learning, motivation, and class dynamics finding positive responses towards all elements. Plump and LaRosa (2017) found that 88.7% of 139 students responded positively towards Kahoot!. They also found that a small proportion (9.1%), however, responded negatively due to the discouragement some students felt in response to the competition element of Kahoot!. Iwamoto et al. (2017) reported statistically significant differences in test scores between an experimental group (using Kahoot!) and a control group (not using Kahoot!), with the experimental group performing better. Chaiyo and Nokham (2017) also reported that students perceived Kahoot! to improve their concentration, engagements, enjoyment and motivation, and supported learning in general. Yapıcı and Karakoyun (2017) utilized a mixed-approach (qualitative and quantitative) to investigate Kahoot!, and reported that motivation for both educators and students increased when using the tool, and, similar to Iwamoto et al. (2017), they found that Kahoot!'s use had a positive effect on the levels of active participation of students. Ismail and Mohammad (2017) noted in their study that Kahoot! was perceived by students as being fun and effective. They did however find that Kahoot! did not particularly assist in simplifying complex subjects.

2.3 Sentiment Analysis and Inductive Content Analysis

This study partially diverges from existing research on gamification and education since we objectively extract quantitative scores directly from the sentences found in students' interview responses (via sentiment analysis), ultimately allowing for a deeper quantitative analysis to be conducted. Sentiment analysis (also known as Opinion Mining) refers to the area of study concerned with using textual information generated by people to analyze their opinions, emotions and attitudes (Liu, 2011). This addresses a key concern found in the literature regarding Likert-type scales used for quantitative analyses in that such responses are not always consistent with the open-ended comments of students (Wang, 2015). Sentiment analysis allows us to extract similar "scores" directly from students' comments, thus providing us with an alternative ordinal variable which we can use to perform rigorous statistical testing. Furthermore, these outcomes allow us to extract quantitative information on a sentence level, instead of a single score per question, thus introducing another level of depth beyond that of traditional Likert-type responses. Sentiment analysis also allows for the extraction of continuous-variable scores, thus, allowing for a more natural analysis of the results. The usefulness of sentiment analysis has been demonstrated for interviews and educational purposes. For

example, Güven et al. (2014) and Knudson et al. (2016) applied sentiment analysis to interview answers, and Cunningham-Nelson et al. (2016) and Rajput et al. (2016) applied sentiment analysis to teacher evaluations.

Sentiment analysis is also complemented by inductive content analysis, which provides another layer of triangulation (Patton, 1990). This approach involves open coding, where insights are teased out of open-ended responses. Codes are then compared in the development of themes, which are refined into a coherent narrative or account (Braun & Clarke, 2006). Triangulation is used to increase the credibility and validity of research outcomes (Noble & Heale, 2019). Credibility here refers to how believable the study outcomes are, while validity measures the accuracy of the study measures and outcomes. In performing inductive content analysis, we are able to overcome the limitation and bias of using only sentiment analysis, as the former approach involves the actual studying of the data as it is provided. Here the data is read and re-read for patterns where themes are then extracted. These are subsequently compared to the sentiment analysis outcomes in the provision of triangulation. Thus, our findings and conclusions are enriched and presented with confidence.

2.4 Research Questions

Ultimately, this study serves to provide an alternative analysis of gamification and the use of GSRSs in education to triangulate results from previous studies (Bicen & Kocakoyun, 2018; Knudson et al., 2016), and simultaneously addresses the need identified by Dicheva et al. (2015) who stated that more research is required on the use of game elements in specific contexts. Research into the use of games and GSRSs for enhancing learning at the tertiary level has shown that the use of such interventions enhanced exams scores (Tóth et al., 2019), stimulated and motivated students (Pinna et al., 2019), and improved engagement (Holbrey, 2020).

Of more specific relevance, studies focused on informing the theory and practice of IS-related learning where games are employed have shown that GSRSs enhanced classroom interactions and student exam scores (Suja'i et al., 2019). Such games also allowed students to develop a deeper understanding of course concepts and provided opportunities for immediate feedback (Baszuk & Heath, 2020). In addition, junior and senior students relished the opportunity to be part of a learning environment where games were used to support teaching (Owen & Licorish, 2020). In fact, even the use of playing cards for teaching data management and modelling concepts was reported to be enjoyable and enhanced student recall (Agogo & Anderson, 2019). While it is clear that GSRSs and game use in general improve the learning outcomes of students, there is limited work focused on the specific circumstances under which gamification could provide value.

Our insights into the specific circumstances under which GSRSs, and Kahoot! in particular, provide value is particularly noteworthy. This is fundamentally important from an educational and pedagogical perspective since the usefulness of a tool is maximized in contexts where its strengths directly address a problem in the classroom. Furthermore, Dicheva et al. (2015) also noted that the gamification of learning effectively is complex, and that further studies may provide guidance on when gamification is appropriate and effective. Accordingly, the work investigates students' responses (and lecturers' reflections) on the effects of Kahoot! on their motivation, engagement, and class dynamics by answering the following research questions:

RQ1. What are university students' sentiments around Kahoot!'s influence on class dynamics, engagement and motivation?

RQ2. Are there differences in university students' sentiments towards Kahoot!'s use across different classes?

RQ3. Are university students' sentiments expressed towards Kahoot!'s use associated with personal and academic factors?

RQ4. Under what specific circumstances does Kahoot! provide value? Aspects covered here include: (1) how is Kahoot! effective? (2) why is it effective? and (3) how could it be more effective?

3. METHODOLOGY

Sentiment analysis is utilized in this study to quantify and compare the responses received from university students taking IS courses relating to the use of Kahoot! as a learning tool. Inductive content analysis is then performed to provide contextual details for the specific circumstances under which Kahoot! provides value. The following subsections outline the design of Kahoot!, data, methods and tools that were used.

3.1 Kahoot! Design

Kahoot! was utilized as a learning tool at the University of Otago, New Zealand in three Information Science courses in 2016 and 2017. In New Zealand the academic year has three semesters; summer school from January to February, semester one from February to June, and semester two from July to October. Of the courses, one was a first-year course (Information and Communications Technology – COMP111) which was lectured in semester one of 2017, and the other two were third-year courses: Information Systems Strategy and Governance (INFO322) lectured in semester two of 2016, and Software Project Management (SENG301) lectured in semester one of 2017. COMP111 explores fundamentals of Information and Communication Technology (ICT) issues, and the influences and impacts ICT has and may have in the future. INFO322 introduces students to the way organizations strategically use information systems (IS) and information technology (IT) to drive and sustain business processes, including how structures and policies are used in creating value opportunities and enabling corporate governance. In SENG301, students learn and apply skills necessary for implementing software development projects, covering activities from project conception and scoping to software implementation and deployment.

The different uses of Kahoot! in these courses can be defined as follows: (1) As a tool to quiz students on a range of topics in order to better understand their competence of the work – this was used to inform lesson planning (all courses), (2) As a tool to explore and understand the knowledge students possessed on the content delivered in lectures (all courses), (3) As a tool to assist students in gaining a better understanding of their own comprehension of various topics, which was done by allowing them to create their own assessments/games (all courses), (4) As a tool to help introduce classes – this includes students, lecturers, and course topics (only COMP111), (5) As a tool to introduce a break and for the students' enjoyment –

questions were based on unrelated topics (INFO322 and SENG301).

Students were all introduced to Kahoot! very early in the courses, and shown how to play the game. Students would also be notified when games were to be played. Examples of topics covered when Kahoot! was used as a tool to quiz students in order to better understand their competence to inform lesson planning for SENG301 include *Requirements Engineering* and *Effort Estimation*. Examples of topics covered when Kahoot! was used as a tool to explore and understand the knowledge students possessed on the content delivered in COMP111 include *Hardware Basics* and *Communication and Networks*. Examples of topics covered when Kahoot! was used as a tool to assist students in gaining a better understanding of their own comprehension of various topics in INFO322, which was done by allowing them to create their own assessments, include *Organizational Strategies* and *Strategic Information Use*.

The Kahoot! game environment is intended to be an interactive and fun alternative learning option for students. The games are accessed through smart devices (e.g., smartphones, tablets and laptops), where students joined pre-made games to answer a set of questions. The responses of students were then summarized visually at the end of each question, and a leaderboard was shown, thus introducing a competitive element (refer to Figure 1). Figure 2 provides a snapshot of the Kahoot! interface, including an image of the screen projection (image on left), and smart device (image on right), as was implemented during a session of the INFO322 course. A brief introduction to Kahoot! is available here: https://www.youtube.com/watch?v=ch_7HHFwjCU.

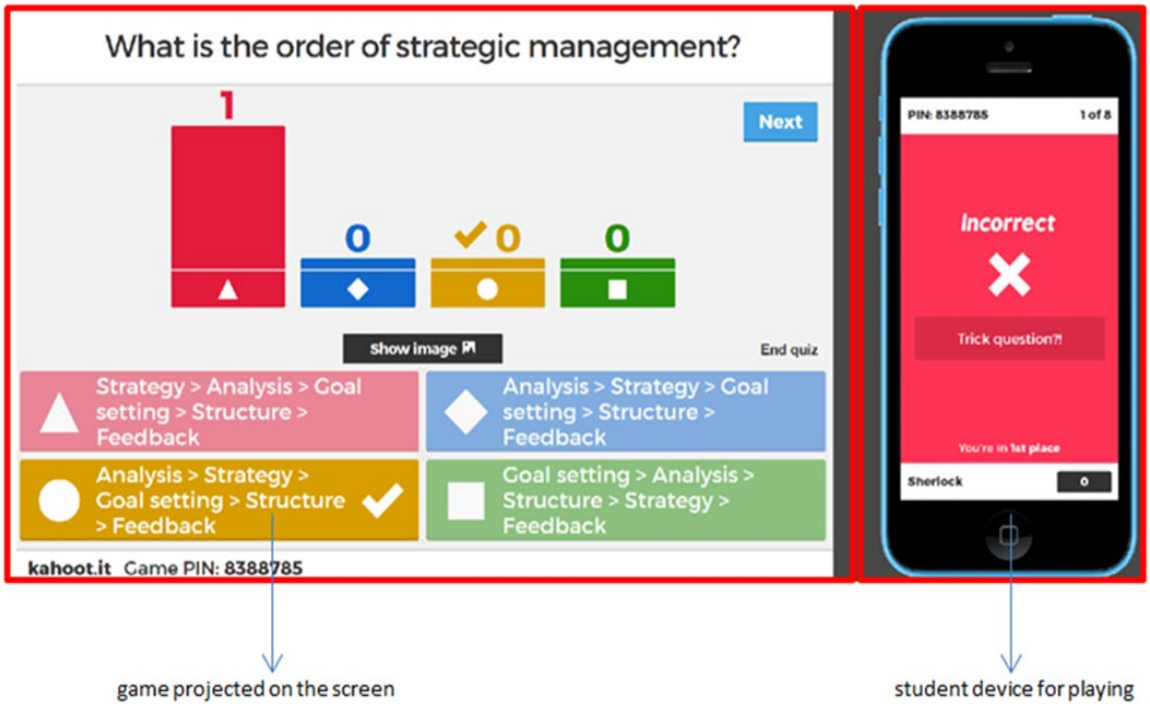

Figure 2. Interface of Kahoot! for INFO322 on Screen and Smart Device

3.2 Data

3.2.1 Interview Transcripts Data. The data analyzed in this study were derived from 38 interview transcripts. Interviews were done in November 2016 (for INFO322) and July 2017 (for COMP111 and SENG301), where a neutral academic and the first author interviewed the students. We were careful to ensure that bias was removed by safeguarding that students were interviewed by someone who did not administer the games in the lecture. For instance, the neutral academic interviewed the COMP111 and SENG301 students, while INFO322 students were interviewed by the first author. Our sample size is comparable to those used in similar studies where both deductive and inductive analyses are performed. For instance, Pinna et al. (2019) used a sample of 35 students in their work, Suja'i et al. (2019) used a sample of 28 students, and Holbrey (2020) used a sample of 44 students. As noted above, our interviews were conducted with undergraduate students at the University of Otago (enrolled in COMP111, INFO302 or SENG301). The age of students involved ranged from nineteen to twenty-six. The sampling of students occurred at the completion of courses, with the use of purposive non-probability sampling. Interviews were recorded and transcribed by transcribers at the University of Otago (New Zealand). Fourteen of these transcripts representing those gathered from INFO322 students were used in a preliminary study, and the remaining 24 transcripts were subsequently recorded as part of ongoing data gathering efforts. Table 1 provides a summarized list of interview participants with supporting demographic information. Of the 38 unique students involved in the study, thirteen were from the course COMP111 (Information and Communications Technology), fourteen were from INFO322 (Information Systems Strategy and Governance), and eleven were from SENG301 (Software Project Management).

Of note is that students could not participate in the interview process more than once. In fact, INFO322 students would typically be completing their final semester at the university, SENG301 students completing their penultimate semester, and COMP111 students are typically first-year students. Thus, the chance of these students overlapping was slim, given that INFO322 students were interviewed first (in November 2016) and were typically leaving the university, while SENG301 and COMP111 students (interviewed in July 2017) were separated by a few years. While there may be students repeating these courses due to failure, as noted above, we screened the students before they were interviewed to ensure they were not interviewed twice.

Within the given interviews, questions were asked in relation to several key themes. These included the previous use of Kahoot! (Q1), how the use of Kahoot! affected the class dynamics, engagement and motivation of the classroom and students (Q2-Q4), if students believed that Kahoot! was a useful learning tool and how (Q5), how students preferred to see Kahoot! used (Q6), students' good and bad experiences using Kahoot! (Q7), and any other open comments (Q8). Students' responses to the first half of the interviews (focused on class dynamics, engagement and motivation) were analyzed using sentiment analysis to answer RQ1, RQ2 and RQ3. Responses to the second half of the interview (focused on usefulness, preferences and experiences) were used to answer RQ4.

The following full questions are examples from the semi-structured interviews:

(Q2) "How do you feel about the changes in the [course] classroom dynamics brought about by Kahoot!?"

(Q3) "Do you feel that Kahoot! increased/decreased your engagement during the [course], and how did it increase/decrease?"

Elaborated responses were sought from the students, thus some students were prompted to provide more information if their initial responses were short. The definitions used in this study are as follows:

Dynamics: Classroom dynamics is defined as the interaction between the students and lecturers.

Engagement: Student engagement is defined as the level of attention, curiosity, focus, and interest which students demonstrated.

Motivation: Motivation is defined as the extent to which there is consistent engagement with the work from students, including classroom interaction.

Course	# Students	Mean age	Gender	Mean duration of study	Mean hours dedicated to course overall (weekly)
COMP111	13	20.5	8 females 5 males	2.7 years	2.0
INFO322	14	21.4	4 females 10 males	3.4 years	6.1
SENG301	11	22.2	2 females 9 males	3.3 years	7.5

Table 1. Summarized Demographic Information

3.2.2 Other Student Data. An additional dataset (including demographic data) was used for this study. This dataset contains personal and course performance data (including grades) on the individuals interviewed. The variables in this dataset include: age, gender, duration of study, hours of lecture preparation per week, hours dedicated overall to the specific course, coursework results, exam results, and final (overall) grade for the course. Students provided personal demographic data prior to the formal interview, and grade data were extracted from course records with their permission. Students' participation in the interviews was voluntary and at the end of the courses where they were no longer expected to undergo any assessment. Thus, their participation in the study had no bearing on their course performance. Students signed a formal consent form before participation in the study as was stipulated by the University of Otago ethical approval process, where the study was granted ethical approval.

3.3 Data Pre-Processing and Sentiment Scores

3.3.1 Text Pre-Processing. In preparing the data for analyses, only the answers to recurrent questions were kept, thus excluding responses to those diverging from the topic at hand. In addition, question-based responses and the researchers' annotations were removed. Furthermore, all texts were converted to their lowercase equivalent for consistent interpretation. As part of the overall 38 interview transcripts, in total, 54 responses were processed on the theme of class dynamics, 58 on engagement, and 62 on motivation, adding up to 174 responses altogether. These 174 responses cover answers to follow up questions for students to elaborate where their initial responses were short, and hence, there were more than 38 responses for each of the three dimensions. The 174 responses comprised 309 sentences, which were analyzed for their sentiments.

3.3.2 Sentiment Scores. The R "sentimentr" package was utilized, which produced augmented polarity scores for each sentence based on two underlying lexicons: Jockers's (2017) Syuzhet package and Hu and Liu's (2004) dictionary from the Lexicon package. Sentimentr (Rinker, 2019) works by first separating paragraphs into sentences, and each sentence into an ordered bag of words. These words (after punctuation is considered and potentially removed) then get assigned a polarity score (e.g., -1 for negative and +1 for positive), based on the predefined polarity assignments given by the dictionary of polarized words. A polarized context cluster is then extracted, using four words before the polarized word occurred, and two after. This is used to detect and correct for valence shifters. Valence shifters have a strong influence on the sentiment expressed in a sentence, with the most common valence shifters considered being: Negations (reverses sentiment), intensifiers (increases sentiment strength), and diminishers (reduces sentiment strength) (Kennedy & Inkpen,

2006). Sentimentr takes these valence shifters into account, thus providing robust results. The end result is a polarity score for each sentence, being between -1 (negative) and +1 (positive). Beyond the detection of valence shifters to reliably predict the sentiment of texts, the R "sentimentr" package is held to allow for the writing of limited code for performing sentiment analysis, thus making it a simple package to use (https://towardsdatascience.com/doing-your-first-sentiment-analysis-in-r-with-sentimentr-167855445132). We thus utilized this package in our investigation.

3.4 Sentiment and Inductive Content Analyses

3.4.1 Analyses for RQ1 and RQ2 (Sentiment Analysis). To answer RQ1 and RQ2 we produced a set of summary statistics, which is comparable to the results of other quantitative studies, and we also conducted regression analysis, to test for relationships between the explanatory variables "theme" and "course," and the outcome which is the polarity score of each sentence. Including both "theme" and "course" in the model allowed us to control for the effects of each variable, and to understand the isolated effect of each on the sentiments expressed by students. Furthermore, to ensure that the analyses were valid we also performed diagnostic checks to see if any of the underlying linear regression assumptions were violated. For RQ1, we test the hypothesis, *when controlling for the given course students are enrolled in, the mean polarity scores for the different themes (class dynamics, engagement and motivation) will be the same*. For RQ2, *we test the hypothesis, when controlling for theme, the mean polarity scores for the different courses will be the same*. We tested for the assumption of normality (i.e., homoscedasticity, normality, and independence) using the Anderson-darling normality test (Anderson & Darling, 1954). Homoscedasticity assesses the variances of the residuals in a regression model to see if they are constant, while normality assesses if a distribution is normal, and independence checks are used to verify the probability of occurrence of two distributions.

3.4.2 Analyses for RQ3 (Sentiment Analysis and Other Student Data). To answer RQ3 we conducted another linear regression analysis. For this analysis, the polarity scores for each individual's sentences were averaged out, which was then used as the outcome variable. The candidate explanatory variables were: Age, gender, duration of study, number of hours dedicated to lecture preparation, number of hours dedicated to course overall, coursework grade, exam grade, final grade, and course. Students' responses to Q1 (i.e., whether or not they had used Kahoot!) were also captured here, albeit very few students responded in the affirmative. A key concern for this analysis was sample size, which was reduced to 38. As a result, our final model could not include all candidate explanatory variables, as this could lead to the production of unreliable model coefficients. According to Miller and Kunce (1973), a sample to predictor ratio of 10:1 should be obtained as a minimum, thus allowing for the inclusion of three explanatory variables (number of hours dedicated to course overall, motivation, and course) in our final model. To investigate potential models, we relied on both forward stepwise regression and manual fitting, which relied on exploratory analysis such as visualizations.

3.4.3 Analyses for RQ4 (Inductive Content Analysis). To answer RQ4 we adopted an inductive content analysis approach to test whether clear themes (of *perceptions*) relating to the value Kahoot! provides appeared in the interview data (Patton, 1990). Under this overarching objective, we teased out: (1) how is Kahoot! effective? (2) why is it effective? and (3) how could it be more effective? The procedure involved open coding where responses to the interview questions were read and re-read for familiarization and initial codes were identified based on explicit, surface-level semantics in the data, rather than implicit responses and preconceptions (see Braun & Clarke, 2006). Through axial coding, codes were recombined and connections were formed between ideas. Then, we used NVivo software to conduct thematic mapping to restructure specific codes into broader themes. Finally, following Braun and Clarke's (2006) selective coding procedure, the resulting themes were refined and organized into a coherent, internally consistent account, and a narrative (story) was developed to accompany each theme. We also provide reflections (from instructors' perspective) around how easy it is to use Kahoot!, the situations where it is effective to use Kahoot!, and how we plan to use it in the future. Table 2 provides a summary of the research questions, variables and analysis methods.

4. RESULTS

4.1 University Students' Sentiments

To answer RQ1, a combination of summary statistics (see Table 3) and regression analysis were used. As noticeable in Table 3, the mean polarity scores ranged from 0.171 to 0.402, implying that students on average had a positive opinion towards the three themes in all courses. Due to the numeric nature of the polarity scores, we were able to statistically test if relationships exist between the themes in question (i.e., dynamics, engagement and motivation) and the polarity scores that were returned from students' responses. The null hypothesis to be tested, when controlling for the given course students are enrolled in, is that the mean polarity scores for the different themes will be the same (i.e., there will be no difference). The results are provided in Table 4, which shows the regression output for RQ1 and RQ2. As noticeable from the results, no statistically significant evidence was found to reject the null hypothesis (i.e., the polarity of the sentiment expressed is not different between the three themes investigated, after controlling for the different courses). Model diagnosis was also performed, where no violation of the assumptions (i.e., homoscedasticity, normality, and independence) mentioned in Section 3 was found.

4.2 Sentiments Across Classes

The null hypothesis to be tested when controlling for "theme" is that the mean polarity scores for the different courses will be the same (i.e., there will be no difference). These results are provided in Table 4. From the results, we can conclude that after controlling for "theme," no statistically significant evidence was found to reject the null hypothesis which stated that no difference in polarity exists between the different courses.

Research Question	Variables	Analysis Method
RQ1. What are university students' sentiments around Kahoot!'s influence on class dynamics, engagement and motivation?	Sentiments (polarity score), class dynamics, engagement, motivation, and course	Sentiment Analysis
RQ2. Are there differences in university students' sentiments towards Kahoot!'s use across different classes?	Sentiments, class dynamics, engagement, motivation, and course	Sentiment Analysis
RQ3. Are university students' sentiments expressed towards Kahoot!'s use associated with personal and academic factors?	Sentiments, course, age, gender, duration of study, hours of lecture preparation per week, hours dedicated overall to the specific course, coursework results, exam results, and final (overall) grade for the course	Sentiment Analysis
RQ4. Under what specific circumstances Kahoot! provides value?	Kahoot!'s effectiveness (how Kahoot! is effective, why it is effective, and how it could be more effective)	Inductive Content Analysis

Table 2. Summary Research Questions, Variables and Methods

Course	Theme	No. Sentences	Mean (Score)	Std. Deviation (Score)	No. Positive	No. Negative
COMP111	Dynamics	46	0.328	0.287	42 (91.304%)	4 (8.696%)
COMP111	Engagement	30	0.237	0.340	25 (83.333%)	5 (16.667%)
COMP111	Motivation	46	0.344	0.282	40 (87.000%)	6 (13.043%)
INFO322	Dynamics	32	0.347	0.310	27 (84.475%)	5 (15.525%)
INFO322	Engagement	22	0.402	0.392	19 (86.364%)	3 (13.636%)
INFO322	Motivation	15	0.171	0.304	13 (86.667%)	2 (13.333%)
SENG301	Dynamics	44	0.231	0.267	35 (79.545%)	9 (20.455 %)
SENG301	Engagement	34	0.267	0.265	29 (85.294%)	5 (14.706%)
SENG301	Motivation	40	0.273	0.280	33 (82.500%)	7 (17.500%)

Table 3. Summary Statistics

Coefficients:	Estimate	Std. Error	t-value	p-value
(Intercept)	0.314102	0.034866	9.009	< 0.001
Engagement	-0.004678	0.042230	-0.111	0.912
Motivation	-0.004283	0.040612	-0.105	0.916
INFO322	0.014807	0.045537	0.325	0.745
SENG301	-0.055827	0.038750	-1.441	0.151

Table 4. Regression Output for RQ1 and RQ2

4.3 Sentiments Association with Personal and Academic Factors

Table 5 provides the regression model for answering RQ3, where the variables of interest returned are: "Hours dedicated to course overall" (HDO) and "Course." These variables were found to be most plausible in terms of their relationship with average sentiment, although at first glance other variables may have had a stronger correlation with the average sentiment. For example, hours dedicated to lecture prep had a stronger correlation with average sentiment; when investigating the results, however, we noted that the correlation was mostly spurious. Thus, although plausible (especially when considering how Kahoot! provides a test-like environment which may encourage more preparation by students), given the nature of the data we decided to choose the overall hours dedicated to the course as the relationship was clearer here (estimate = 0.02074), especially when controlling for course.

The results show that when controlling for course, there is statistically significant evidence ($p < 0.05$) that the number of hours dedicated to the course (overall) is related to the average polarity of sentiments expressed by students. Furthermore, weak statistical evidence ($p = 0.0566, < 0.1$) was found for SENG301, thus implying that when controlling for the number of hours dedicated to the course overall, students' in SENG301 have a less-positive perception of Kahoot! compared to COMP111 (reference group) and INFO322. It should be noted that gender did not impact students' sentiments towards Kahoot!. A visualization of the HDO against the average sentiment that was expressed is provided in Figure 3, which shows that SENG301 had lower sentiment scores on average. The circles, triangles and squares in Figure 3 represent the data

points for the hours students dedicated to their courses overall (x-axis) against their average sentiments (y-axis).

To ensure the validity of the model and our conclusions, the assumptions underlying the linear regression model were tested. The Anderson-darling normality test (Anderson & Darling, 1954) of 0.17 ($p = 0.93$) indicated that we can continue to assume normality. Furthermore, a Q-Q plot done also allowed for a visual diagnostic of normality, which appeared sufficient. Furthermore, all other diagnostic plots appeared reasonable, and no apparent violations of the underlying assumptions were observed.

Coefficients:	Estimate	Std. Error	t-value	p-value
(Intercept)	0.26323	0.04395	5.990	< 0.001
HDO	0.02074	0.01011	2.051	0.0481*
INFO322	-0.05553	0.06858	-0.810	0.4237
SENG301	-0.15765	0.07987	-1.074	0.0566

Table 5. Regression Output for RQ3

4.4 Kahoot! Value in Specific Circumstances

In answering RQ4, our inductive content analysis of the students' data returned several subthemes under the overarching Kahoot! value theme. We grouped these subthemes under three dimensions: (1) how is Kahoot! effective? (2) why is it effective? and (3) how could it be more effective? We also provide reflections on our experiences using Kahoot! in Section 5 (as instructors).

4.4.1 How Is Kahoot! Effective? Kahoot! helps with *attention* and *focus* as students are allowed the opportunity to have a *break*. A SENG301 student noted: "…*To have that break where you're still thinking about things but in a more interactive way and in a different style than a lecture, made it easier to concentrate on the next half hour or so of the lecture*…" Students also relish the opportunity to be part of a classroom where something *different* is used to inform their learning. An INFO322 student noted: "…*It was more than usual, usually you see the lecturer present their notes for the day and that would be it, and there's next to no interaction so to have the whole class interact and have the lecturers actually get in there and ask for opinions was different*…" Students internalize the difference as *innovative* when compared to typical power point or video lectures. A COMP111 student noted: "…*When you compare that to a more classical learning environment, I think that is necessarily more beneficial. I can even look at my grades in comparison to themselves because I think if we take COMP111 and compared it to my accountancy course I took in the same semester, my COMP111 grades were far better, and my accountancy grades weren't quite as good. I think that contrasts the two systems rather well even though I felt roughly the same about the material in terms of my interest in it. I'd certainly say that "Kahoot!" is good at pushing that kind of knowledge across, especially when it's quite new kinds of knowledge…*"

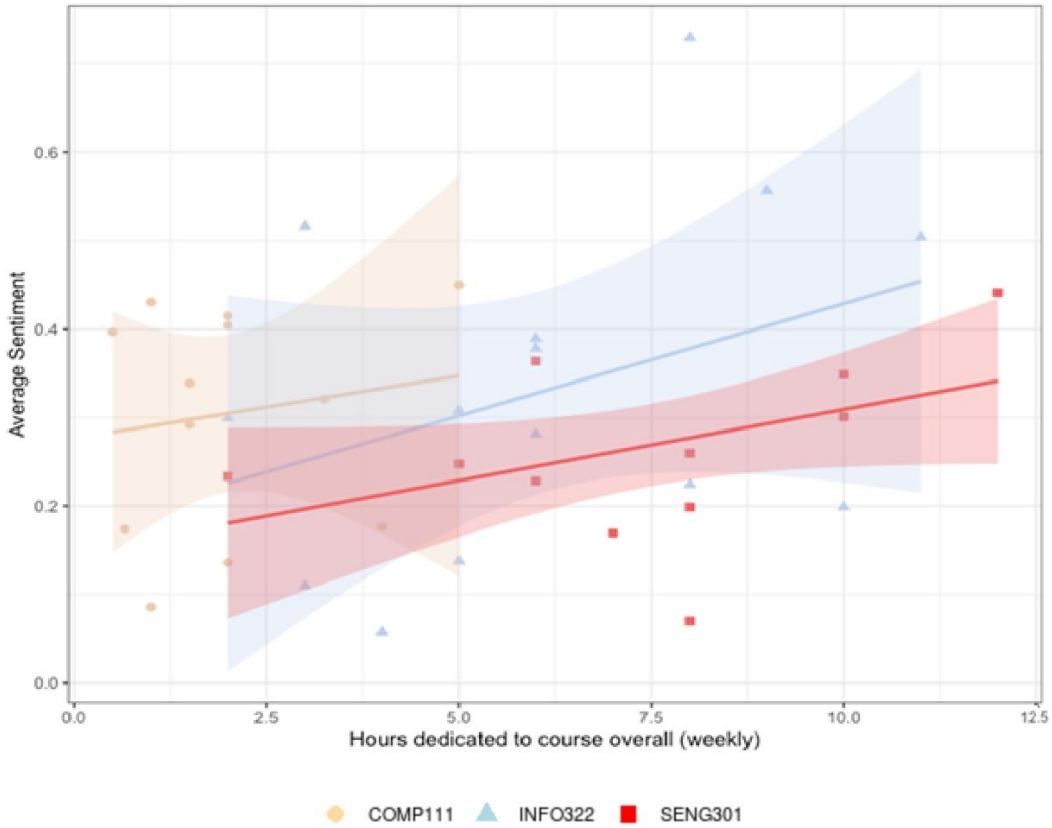

Figure 3. Hours Dedicated to Course Overall (per week), Adjusting for Course

In addition, students noted that Kahoot! encouraged *interaction*, which was useful for refining their knowledge. A COMP111 student noted: "…*It definitely gets everyone engaged and I found it was more fun coming to class than listening to a lecturer... Typically when I'm sitting in a lecture, I'm sort of passive listening and furiously attempting to get down as much of the notation as I possibly can. But I think with the "Kahoot!" system it was quite useful in that you were actively engaged in the learning process a little more*…" The enhanced interaction also encouraged wider *participation* by students that are typically silent, as the classroom now becomes an environment where everyone is driven to perform, and thus, there is less interest in focusing on others. An INFO322 student noted: "…*It also allowed our students to review and understand the concepts, just little questions, could be this, could be this, so it was definitely a positive interest and the whole INFO322… It wasn't a standard boring lecture where you could sit there and read the notes later on, because you needed them later on*…"

Through the wider participation there are many opportunities to *learn*, especially during instructors' *reflections* when incorrect answers are chosen. A SENG301 student noted: "…*When you find your answer is correct, you will know how it is correct, and even talk with your fellow class members about how it is correct. Maybe you have a note you want to share with the class or ask for more information regarding this question to the lecturer. It will help you to interact. The other way is that if your answer is wrong, it will help more for the student to know why his answer is wrong, what the correct answer is* …" Central to students' enthusiasm and Kahoot!'s effectiveness was the *fun* gameshow like setting that is created when Kahoot! is played. Students felt like the classroom was no longer a place of scrutiny. A COMP111 student noted: "...*I think "Kahoot!'s" success was in its ability to be a little bit more engaging, a little bit more fun and interactive, make it seem a little bit more user friendly... making students feel as if they are engaged a lot more in the learning environment*…"

4.4.2 Why Is Kahoot! Effective? Having a break allowed students to *refresh/reset*, and thus, Kahoot! enhanced students' ability to concentrate a bit more than usual. An INFO322 student noted: "…*To remember what you learned at the start of that section is a bit difficult when you get to the end and you've got all this information so that would be a good way to refresh and sort of re-grasp those concepts that you might have forgotten*…" In addition, Kahoot! is effective because it facilitated two-way *communication* and promoted student-student and student-instructor *discussions*, which was held to be notable when assessed against other lectures. A COMP111 student noted: "…*I think if you were there, you were much more interactive with the lecturer and like, going off his answers and stuff like that… It's definitely way more engaging with the lecturer and the class; it's a bit more of a two-way thing rather than just the one way*…" In fact, this sentiment around enhanced communication cut across all three courses. For instance, an INFO322 student noted: "…*It was more than usual, usually you see the lecturer present their notes for the day and that would be it, and there's next to no interaction so to have the whole class interact and have the lecturers actually get in there and ask for opinions was different*…" A SENG301 student noted: "…*When you find your answer is correct, you will know how it is correct, and even talk with your fellow class members about how it is correct. Maybe you have a note you want to share with the class or ask for more information regarding this question to the lecturer. It will help you to interact. The other way is that if your answer is wrong, it will help more for the student to know why his answer is wrong, what the correct answer is* …"

Kahoot! helps students to evaluate their knowledge, and thus supports *revision* efforts. This is particularly effective as students are offered the opportunity to *clarify* their understandings within the lecture session. An INFO322 student noted: "…*It was a way to interact and grab your attention and it was also a just quick way to sit there and go over these concepts because if you had forgotten it, it was a quick way to remember, going oh okay, oh I got the wrong answer*…" Students are also able to *compare* their responses with their peers'. *Tension* that is typical in a learning setting where students can at times worry about "being wrong" was reduced due to the gameshow environment Kahoot! creates. A SENG301 student noted: "…*It did provide that; everybody had a chance to sort of relax from focusing on the lecture and facts and sort of be social about it*…"

4.4.3 How Could Kahoot! Be More Effective? Kahoot! can leave some students feeling *embarrassed* when they get questions wrong, which may be caused by the *hurry* to add an answer to move up the leaderboard or timer (clock) pressure. A SENG301 student noted: "…*There was a focus on trying to get as many points from "Kahoot!" as you could because it rewarded you with points, and sometimes I would lose the focus of the learning aspect and just focus on trying to get the most points*…" Some students felt that Kahoot! should be played when there is *pertinent content* to revise, so that students can see the value of the tool and maintain interest in the games. Otherwise, students can at times employ *guessing* when they are not knowledgeable of the content, which defeats the purpose of using the tool in support of learning. An INFO322 student noted: "…*Yeah, sometimes like the questions or the answers were just jokes, stuff like that, there's no point to that. I think it got boring because it felt like it was just more of a fun pub quiz kind of thing… Most of us and the people around me were just guessing, there were a couple of people that took it seriously and that was good and then personally I get distracted quite easily so when people start doing that and joking around you get led into doing that*…"

This suggests that it is necessary for Kahoot! to be played after students have acquired knowledge of the subject area for such sessions to be most meaningful. The *timing* of gameplay is thus very important if Kahoot!'s use is to be effective. This extends to the *frequency* of play and *length* of the Kahoot!, which are typically enjoyable if played for 5-15 minutes. A SENG301 student noted: "…*If it were every hour session, it would be far too much and it would lose its charm very quickly. It would become just as boring and mundane as a lecture would. I think it's quite good that it's brought at the end of the session… The last "Kahoot!" was quite big, and I noticed students started to lose interest after 12 questions so they just stopped playing or they were choosing anonymously*…" That said, students value the discussions that follow Kahoot!, and so adequate time should be reserved for instructors' *explanation* of concepts, theories, and principles after Kahoot! games are played. A COMP111 student noted: "…*If you can't answer that question, you can go, 'can you please explain that further?'.*

You're going to get asked questions on your test, so it's a good way of having an exam question, and you have a go at answering it… As long as they explain how they got that answer. For example, 'What is RAM?' – 'Random-access memory.' Then you explain, 'Random-access memory is used for the start-up process of the computer.' So instead of just knowing the answer, it's better to actually understand the answer as well. So, I reckon they can go together quite well, just explaining the answer to the class afterwards, even if it's just a short explanation while everyone is still listening…" We provide a summary of our findings drafted as recommendations in Table 6.

Recommendations	
1.	Alternate play between different types of Kahoot!s during lectures to reduce students rushing to answer questions. Educators may alternate between the puzzle, poll and quiz options.
2.	Be cautious with the use of the timer, as all questions are not equal. Extend the timer for questions that demand more critical thinking.
3.	Limit gameplay of Kahoot! to situations when there is pertinent content to revise, so that students can see the value of the tool and maintain interest in the games. This will also limit guessing, which can devalue the use of the tool for supporting learning.
4.	Link Kahoot! games to the assessment of specific learning outcomes to enhance students' satisfaction and maintain the relevance of gameplay.
5.	Deeper comprehension type learning sessions are not properly supported by some forms of Kahoot! quizzes (e.g., true/false or multiple choice). Such sessions may be enhanced by careful question design and using the "slide with text, image, or video" option, which may be a bit time-consuming for instructors, but is likely to support deeper reflections during extended discussions.
6.	Kahoot! played after students are knowledgeable create most classroom excitement and involvement, thus, effort should be committed to careful planning of lessons to deliver this value.
7.	The timing of Kahoot! gameplay is important if Kahoot! use is to be effective. This extends to the frequency of play and length of the Kahoot!, which are typically enjoyable if played for 5-15 minutes.
8.	Kahoot! should be planned to confirm students' knowledge, as students are often very anxious to validate achievement of learning outcomes through gameplay. Such games generate excitement and stimulate the best class atmosphere.
9.	Adequate time should be reserved for instructors' explanation of concepts, theories and principles after Kahoot! games are played. Students find these explanations very valuable, especially for refining and extending their knowledge.

Table 6. Summary Recommendations for IS Educators Adopting Kahoot!

5. DISCUSSION AND IMPLICATIONS

This study was carried out to assess how students reacted to the use of GSRSs, and particularly Kahoot! in IS courses at the university level, and the circumstances under which Kahoot! provides value. Specifically, we were interested in discovering if students, such as those in different courses, years of study, or age groups reacted differently towards the use of Kahoot! (RQ1 and RQ2). We were also interested in understanding whether or not students responded more positively towards certain "themes" given personal and academic factors (RQ3), which would allow us to better understand the strengths and weaknesses of Kahoot! when implemented and used in IS courses to support learning under a range of conditions and subject areas. Finally, we explored under what specific circumstances Kahoot! provides value (RQ4), covering: (1) how Kahoot! is effective? (2) why is it effective? and (3) how could it be more effective? We discuss our findings and their implications below.

RQ1. *What are university students' sentiments around Kahoot!'s influence on class dynamics, engagement and motivation?* Outcomes in this work show that university students' responses towards Kahoot! were very positive, with the lowest percentage polarity being seen for the "Class Dynamics" theme in the Software Project Management course, at 79.5% positive, and the highest being for "Class Dynamics" in Information and Communications Technology, at 91.3%. Classroom dynamics here refers to the interaction between the students and lecturers and its support for helping with learning. A COMP111 students noted: "*…I thought Kahoot! was good. It was the first time I've used it in any lectures. I think it was really easy to use, and you don't have to actually download the app, you can just use it on your phone, and how you can just take your phone, you don't have to bring in your laptop or anything, so I think it was good…*"

These findings are nearly identical to the findings of Plump and LaRosa (2017), who obtained an 88.7% positive response rate towards Kahoot! through their questionnaire-based study. The percentage of positive results, however, was higher for the theme of "Motivation" in these IS-related courses compared to language-based courses, such as that of Zarzycka-Piskorz (2016), who reported that 70% of students were motivated to learn course content as a result of Kahoot!. Although the nature of the questions asked were different between our study and this author's, it is plausible that this figure may be higher for IS-based courses, which needs further consideration by follow up work.

In contrast to these studies, our sentiment analysis based approach enables us to perform quantitative analyses without having to rely on Likert-based responses, which is often miss-matched with individuals' responses (Wang, 2015). Furthermore, it also allowed us to extract a numerical score for each sentence, thus allowing students to express both positive

and negative sentiments towards aspects of Kahoot! at the same time.

RQ2. *Are there differences in university students' sentiments towards Kahoot!'s use across different classes?* Using the extracted polarity scored, we discovered no significant difference regarding the polarity of responses from students in terms of the different themes under consideration (i.e., class dynamics, motivation, and engagement), which all attracted positive student responses, after controlling for the different courses. Furthermore, no statistically significant differences were observed between the polarities of the responses of students between the different courses, after controlling for the question themes.

Our outcomes here suggest that Kahoot! provided a positive experience for IS students when used regardless of the courses that were being undertaken (Suja'i et al., 2019; Wang & Lieberoth, 2016). Of note here is that these courses ranged from introductory knowledge (Information and Communications Technology – COMP111) to more specialist IS content (Information Systems Strategy and Governance – INFO322). COMP111 explores fundamentals of ICT issues, and the influences and impacts ICT has and may have in the future. Students enrolled in this course are typically starting their university studies or interested in exploring the utility of merging their major subject area (e.g., accounting) with IS. Thus, these students are not likely to be as mature and certain about their IS knowledge as those that are more senior (Sabourin et al., 2013). INFO322 introduces students to the way organizations strategically use IS and IT to drive and sustain business processes, including how structures and policies are used in creating value opportunities and enabling corporate governance. Those enrolled in this course are typically advanced in their learning, and ready to embark on careers that involve ICT (e.g., as a Business Analyst).

We see that Kahoot! supported learning for both levels of students, those now starting out and those more advanced in their knowledge, as it had done for other IS students (Agogo & Anderson, 2019; Baszuk & Heath, 2020; Owen & Licorish, 2020). It is anticipated that advanced students may be more experienced in strategizing to perform well, and so gameplay should be less useful for this group. In addition, the higher level of cognitive focus required of more advanced courses may reduce students' tolerance to anything that could be distracting (Méndez & Slisko, 2013), including gameplay using Kahoot!. However, our findings did not support this conjecture, as such students seemed as enthusiastic as the former (i.e., those starting out), as was the case for other settings (Bicen & Kocakoyun, 2018; Licorish et al., 2017; Plump & LaRosa, 2017).

In fact, Kahoot! was also positive in the case of Software Project Management – SENG301, where students learn and apply skills necessary for implementing software development projects, covering activities from project conception and scoping to software implementation and deployment. Students involved in this course are typically self-motivated, as they are required to solve very complex abstract problems with software (e.g., developing software for managing the university's library). Kahoot! provided the same support to these students as it did the former, confirming its utility across university IS courses.

RQ3. *Are university students' sentiments expressed towards Kahoot!'s use associated with personal and academic factors?* Additional analyses were conducted to test for relationships between a set of personal and academic variables, and the polarity score of students' responses. Our analyses showed that there are statistically significant relationships between the time students dedicate to their studies (strong evidence: $p < 0.050$), and the actual course (weak evidence: $p = 0.056$, < 0.1). Thus, we provide evidence that students who spend more time on their courses tend to respond to Kahoot! more positively. We assume that, in general, students who are more dedicated to their work respond better to tools dedicated to enhancing their learning. An interesting result, however, was that the course variable was also found to be significant. This outcome goes beyond the results discussed previously, in showing the subtleties of the sentiments students recorded for the different courses, where there was more intense positivity reported for student enrolled in COMP111 and INFO322 than SENG301.

We can see that when considering the course, and the number of hours dedicated to a course, that adjusting for course allows us to obtain positively linear relationships between the number of hours dedicated to study and the polarity score of students' responses. The results do agree in terms of the course which received the least positive comments, which is Software Project Management (see Figure 3). A SENG301 student noted: "*…I didn't really like the competition aspect personally. There was a focus on trying to get as many points from Kahoot! as you could because it rewarded you with points, and sometimes I would lose the focus of the learning aspect and just focus on trying to get the most points…*" The negative effects of competition promoted by Kahoot! have been previously reported (Plump & LaRosa, 2017). Thus, there is some evidence to suggest that there is need for considering specific configurations of Kahoot! for certain courses to ensure its effectiveness as a teaching support tool. That said, GSRSs are often thought of as a dialogue game in which a desired and ongoing educator-student conversation, involving critical discussion and reasoning, exploratory talk, and creative thinking, leads to effective conceptual change and promotes knowledge acquisition (Ravenscroft, 2007; Wang & Tahir, 2020). Some courses may involve less need for these activities, making Kahoot! less potent when used as compared to others. We look at the specific contextual evidence around Kahoot!'s value next.

RQ4. *Under what specific circumstances does Kahoot! provide value?* Kahoot! provided value under all circumstances of use in the IS courses where it was employed at the University of Otago. In terms of ***how Kahoot! is effective***, we observed that Kahoot! helps with attention and focus as students are allowed the opportunity to have a break. Students also relish the opportunity to be part of a classroom where something different is used to inform their learning, which they internalized as innovative. In addition, students noted that Kahoot! encouraged interaction and wider participation, which offered more opportunities to learn, and for refining of their knowledge. Kahoot! also encouraged reflections and supported student-instructor interactions in a fun-filled environment.

In the consideration of ***why is Kahoot! effective***, it was noted that Kahoot! permits timely breaks, and having a break allowed students to refresh/reset, which enhanced their ability to concentrate. In addition, Kahoot! is effective because it facilitated two-way communication and promoted student-student and student-instructor discussions. Further, Kahoot! helps students to evaluate their knowledge, and thus supports

revision efforts. This is particularly effective as students are offered the opportunity to clarify their understandings within the lecture session. Students are also able to compare their responses with their peers', and tension that is typical in a learning setting where students can at times worry about "being wrong" was reduced due to the gameshow environment Kahoot! creates. This underscores the fun element of Kahoot!, which tends to cause students to be absorbed in the learning process.

There are several ways to make ***Kahoot! most effective***. Among these, we observed that Kahoot! can leave some students feeling embarrassed when they get questions wrong, which may be caused by the hurry to add an answer to move up the leaderboard or timer (clock) pressure. This could be reduced by alternating play between different types of Kahoot! during lectures (e.g., using a puzzle or poll as against a quiz) and extending the timer where some questions may demand more critical thinking. Some students felt that Kahoot! should be played when there is pertinent content to revise, so that students can see the value of the tool and maintain interest in the games. Otherwise, students can at times employ guessing when they are not knowledgeable of the content, which defeats the purpose of using the tool in support of learning. This could be mitigated by linking Kahoot! to the assessment of learning outcomes.

Students are often aware that classroom time is precious, and thus, playing Kahoot! without a specific strategic focus could be counterproductive to their learning, and in fact may lead to dissatisfaction. Also, deeper comprehension type learning sessions are not properly supported by some forms of Kahoot! quizzes (e.g., true/false or multiple choice). This could be mitigated by careful question design and using the "slide with text, image, or video" option, which may be a bit time-consuming for instructors, but is likely to support deeper reflections during extended discussions. The timing of gameplay is also very important if Kahoot! use is to be effective. This extends to the frequency of play and length of the Kahoot!, which are typically enjoyable if played for 5-15 minutes. Kahoot! played after students are knowledgeable create most classroom excitement and involvement, thus, effort should be committed to careful planning of lessons to deliver this value. To avoid boredom, Kahoot! should be planned to confirm students' knowledge, as students are often very anxious to validate achievement of learning outcomes through gameplay. Discussions that follow Kahoot! are particularly valuable to students, and so adequate time should be reserved for instructors' explanation of concepts, theories and principles after Kahoot! games are played.

Instructors' Reflections: From an instructor's perspective, our experiences to date using Kahoot! are very positive; however, there are definite ways to maximize Kahoot!'s benefits which should be taken into consideration if the tool is considered for use.

Firstly, gender did not affect the pattern of outcomes observed in the inductive content analysis. In terms of ease of use, Kahoot! was used to quiz students and inform lesson planning, to explore and understand the knowledge students possessed on the content delivered in lectures, to assist students in gaining a better understanding of their own comprehension of various topics, to help introduce classes and to give students a break. The tool was very purposeful under all circumstances of use, and supported our planned activities well. However, Kahoot! does not always provide the intended value, and thus there is need to strategize around the tool's use to deliver maximum benefit to students. For instance, as noted above, faced with the pressure to provide an answer rapidly either to gain points or satisfy the question timer, students can at times rush to add an answer or even revert to guessing. This could be reduced by alternating play between different types of Kahoot! during lectures (e.g., using a puzzle or poll as against a quiz) and extending the timer where some questions may demand more critical thinking.

In addition, although students are happy to play Kahoot! games, the use of the tool needs to be linked to the assessment of learning outcomes. Students are often aware that classroom time is precious, and thus, playing Kahoot! without a specific strategic focus could be counterproductive to their learning, and in fact may lead to dissatisfaction. Also, deeper comprehension type learning sessions are not properly supported by some forms of Kahoot! quizzes (e.g., true/false or multiple choice). This could be mitigated by careful question design and using the "slide with text, image, or video" option, which may be a bit time-consuming for instructors, but is likely to support deeper reflections during extended discussions.

Kahoot! played after students are knowledgeable create most classroom excitement and involvement, thus, effort should be committed to carefully planning lessons to deliver this value. In fact, Kahoot! could be overplayed, becoming boring for some students. Linking the Kahoot! games to the assessment of learning outcomes tends to mitigate boredom however, as students are often very anxious to validate achievement of learning outcomes through gameplay.

Finally, instructors should strategically target the development of Kahoot! games aimed at assessing the knowledge and comprehension skills of students. Kahoot! can be routinely used to test students' ability to memorize content, which may not be ideal in all circumstances. This is particularly necessary for instances where students are required to apply knowledge (e.g., as in the SENG301 course sessions), and where students are most disengaged. We plan to adopt these recommendations during our future use of Kahoot!, and recommend the employment of these strategies to those using GSRSs.

6. CONCLUSION AND FUTURE WORK

On the premise that there remains uncertainty around the specific circumstances under which GSRSs, and Kahoot! in particular, provide value for educators, we used sentiment analysis and inductive content analysis to explore this issue. We study: (1) What are university students' sentiments around Kahoot!'s influence on class dynamics, engagement, and motivation? (2) Are there differences in university students' sentiments towards Kahoot!'s use across different classes? (3) Are university students' sentiments expressed towards Kahoot!'s use associated with personal and academic factors? and (4) Under what specific circumstances does Kahoot! provide value? Outcome show that university students' responses towards Kahoot! were very positive. This positivity was consistent for class dynamics, motivation, and engagement. We observed slightly more intense positivity towards Kahoot! reported for student from some courses or if students spent more hours studying. Further, Kahoot! provided value under all circumstances of use in the IS courses where it was employed at the University of Otago, and was deemed to be very effective.

We suggest various ways to maximize this effectiveness in this work.

Further research is required, however, to validate these results and to investigate the underlying causes behind our findings. For instance, pertinent open questions are: Does the personality of students come into play when Kahoot! is used? Are conscientious students most likely to favor GSRSs use? Can Kahoot!'s use be adapted given the nature of course content to be delivered and students behavioral preferences, thus positively impacting the learning outcomes of all students?

Further research is also warranted for investigating our finding for the positive relationship between the number of hours dedicated to study and the polarity score of students' responses. Kahoot!, as mentioned before, is a tool which draws upon gamification to enhance engagement, motivation, class dynamics, and overall learning of students in an academic setting. A key issue it is meant to address is the fact that students often perceive certain classes as boring, thus negatively affecting their participation and engagement in the material. An INFO322 student noted: "*...Definitely my engagement increased, because Kahoot! allowed us to review and understand the concepts, just little questions, could be this, could be this, so it was definitely a positive interest and the whole INFO322 it wasn't a standard boring lecture where you could sit there and read the notes later on…*"

If the students who are already highly engaged in their courses respond better to Kahoot! or other GSRSs, then its effects on the ideal target group (disengaged students) may not be targeted as effectively. As such, further research is required to understand how well Kahoot! and other GSRSs work for those students who are most disengaged in courses, with the intention of catering to these students' more effectively.

7. LIMITATIONS

We concede that our work suffers from limitations which are to be considered when assessing the findings that are presented. First, the sample studied came from one university and comprised of interview transcripts from 38 students studying across three IS courses (COMP111, INFO302 and SENG301), which may not be generalizable to other tertiary, secondary or primary settings. Our sample, however, compares to those used by other similar studies. While the use of Kahoot! was similar in the three courses, with the exception of the "introduction of classes" in COMP111 and "deliberately for breaks" in INFO322 and SENG301, we concede that the latter differences may have influenced variances in the students' perceptions across the courses. That said, overall, we believe that the multi-method approach that was used in this work and analysis performed across many responses would limit the differences observed. In addition, students were interviewed, and their responses analyzed using inductive content analysis, which may introduce subjectivity bias. The opportunity to interview students, though, gave us a chance to probe their responses in clarifying that they properly understood what was being asked (which is not afforded with questionnaires). Finally, the sentiment analysis method that was used in this work may not provide 100% accuracy, although it is highly recommended for conducting this type of analysis.

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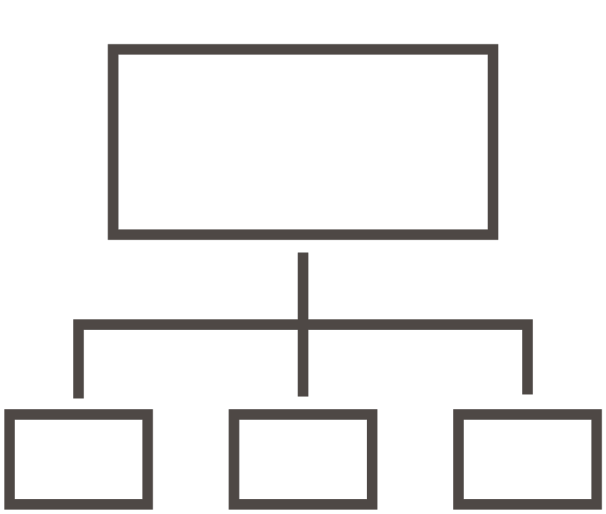

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