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Student Perceptions of Collaborative and Blended Learning in Food Science and Technology

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Abstract

Blended learning refers to the use of conventional face-to-face learning experiences in combination with online education resources and practices. An increase in enrolments and a more diverse student body has intensified the demand to develop first-year teaching and learning pedagogies. Food science and technology lecturers must facilitate constructive learning in order to develop student skills, including critical thinking, teamwork, and self-directed learning. The aim of this investigation was to evaluate student perceptions of collaborative and blended learning. Students were exposed to various technology-enhanced pedagogical tools and face-to-face teaching strategies such as online academic journal reflections, video screencasts, group assignments, food processing practicals, and group crossword puzzles. A mixed-method survey consisting of multiple-choice, a 5-point Likert scale, and open-ended qualitative questions was administered via Blackboard. A total of 133 students were registered for the module, and 72.1% (n = 96) completed the survey. In this study, respondents felt they were prepared to complete the online group assignments (82%), which illustrates that they could learn the course material through collaboration.
Moreover, 87% of the students agreed that they could keep up with the coursework in the blended format. Students recommended that there should be more lecture designed video screencasts, and they should be offered more opportunities to do oral presentations in this module. The respondents positively received collaborative and blended learning. The findings of this study, in general, affirm the merits of incorporating blended and collaborative learning in food science and technology curricula.

Keywords: Blended learning; Food Science and Technology; Collaborative learning; Flipped classroom; Constructivism; Blackboard

1 Introduction

Various studies and reports suggest a clear need for improved science education, not only in content but in the manner in which information is taught (Duffrin, 2006; Gezer-Templeton et al., 2017; Ma et al., 2018). Contrary to surface learning, deep learning is an essential strategy that enables students to extract meaning from course material and experiences. In the context of higher education (HE), the transition from high school to university can be challenging for some students. The challenges of this transition are amplified by the fact that a large percentage of students come from low-income families with an under-resourced and sometimes dysfunctional educational system (Pillay & Gerrard, 2014). Given these challenges, educational in-

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Nomenclature

UoT	University of Technology		ogy
DFST	Department of Food Science and Technology	MCQ	Multiple Choice Question
		LMS	Learning Management System
CPUT	Cape Peninsula University of Technol-	FOT150S	Food Technology 1

stitutions worldwide are increasingly embracing blended learning strategies to deliver course content to a diverse and dispersed cohort. Blended courses, which incorporate online and conventional instruction delivery, may be more conducive to classroom participation than purely online or face-to-face lessons (Bohlscheid & Davis, 2012), and they can also be used effectively in larger classes to improve learning (Meyer et al., 2014; Okaz, 2015; Poon, 2013). Understanding how students feel about blended learning can help inform future implementation of blended activities in food science and technology, tailoring educational activities to suit student preferences likely to increase student engagement. This paper describes a study conducted in an undergraduate food science and technology course to examine the students' perceptions of blended and collaborative learning.

1.1 Blended learning

From a pedagogical point of view, electronic education can shift the paradigm from passive, teacher-centred learning to active student-centred learning (Flores et al., 2016; Kavadella et al., 2012; Liceaga et al., 2011). This new paradigm positions students at the centre of the learning process, with models that stimulate curiosity, creativity, collaboration, and knowledge that is acquired outside the classroom. Compared to student-centred learning, the conventional didactic lecturing model with teacher-centred learning seems less interesting for students in terms of motivation and achievement (Marchalot et al., 2018). In the context of this study, blended learning is defined as a thoughtful amalgamation of classroom face-to-face and online learning experiences with the view to enhance student learning experiences. Lecturers can combine online and face-to-face training in several ways.

Graham (2006) categorizes blends into three types: facilitating blends, which concentrate on simplicity and accessibility; enhancing blends, which supplement but do not radically alter the pedagogical style; and transforming blends, which shift the instructional delivery to an active learning model. According to Graham (2006), transforming blends enable students to actively build knowledge and participate in intellectual activity that would be difficult without technology.

One common form of blended learning that lecturers use allows students to complete activities online prior to face-to-face meetings to ensure that everyone is on the same page. The material can then be augmented and enriched with application-based and problem-solving exercises during class time. The flipped classroom is a term used to characterize this form of combination (Flores et al., 2016; Mason et al., 2013; Nouri, 2016). The face-to-face time can be used to learn the material at a deeper level and link the content to broader topics (Bates, 2015; Mason et al., 2013). Another type of blend involves teaching the course content during class time and allowing students to think critically and discuss their views about the material through online activities (Thai et al., 2017). Under the blended learning approach, students interact using different online and offline tools (Bliuc et al., 2007; Cabero et al., 2010). To support students'

needs, various forms of convergence between technology-based environments and traditional settings have been proposed, including virtual laboratories (Flint & Stewart, 2010; Hubackova & Semradova, 2016) and flipped classrooms (He et al., 2016; Marchalot et al., 2018; Nouri, 2016). With students' widespread use of laptops and the proliferation of low- and no-cost tools to facilitate online education, the supplemental blended learning model has more opportunities than ever before (Bailey & Smith, 2013). Vaughan (2010) offers some helpful hints for developing a blended learning atmosphere, including a thoughtful mix of asynchronous and synchronous dialogue, versatility and independence in online learning, and expert guidance in a purposeful face-to-face setting. Olmos et al. (2014) suggest replacing around one out of every three lessons with media-rich online experiences, while Korte et al. (2016) advocate for more student-centred learning and reshaping lecturer and student positions. Online learning involves providing students with access to learning resources, facilitating communication and collaborative working among and between students and lecturers (Smyth et al., 2012). The benefits of blended learning pedagogy include enhanced student learning outcomes, greater flexibility for students and lecturers, reduced student withdrawal rates and an ability to foster a professional learning environment, especially when a large number of students are to be taught (Güzer & Caner, 2014; López-Pérez et al., 2011). In food science and technology education, it is imperative to create instructional environments (classrooms) where students are actively involved and engaged in fostering student learning and critical thinking, conflict resolution, and collaboration skills among students to develop competencies in that regard, which will allow them to cope better in a working environment in the future (Ma et al., 2018).

1.2 Collaborative learning

Collaborative web-based applications have created new opportunities for students to interact with their peers, lecturers, and content. Although they are sometimes defined differently, collaborative, cooperative, and team-based learning terms are usually considered to represent the same concept (Kirschner, 2001); in this paper, these concepts are considered comparable, and the term "collaboration" is used throughout the paper. Students engage in small-group activities to share their knowledge and expertise as part of collaborative learning. The lecturer typically works as a facilitator in these student-led events. (Kirschner, 2001; Scager et al., 2016). Frameworks identifying the basic skills for 21^{st}-century learning emphasize the importance of collaboration for facing a constantly changing world (Ellis et al., 2016). Collaborative learning provides social skills such as oral and written communication, cultural intelligence, critical thinking, problem-solving, professionalism, and teamwork, which are essential for future professional work in the field of food science and technology (Hollis & Eren, 2016). Furthermore, collaborative learning is crucial when adapting and responding to new professional requirements of the radically changing workplace. Linton et al. (2014) found that students in group settings achieved significantly better conceptual understanding compared to students in courses with an individual setting. In a study conducted by Hassanien (2006), students perceived that group work fosters the development of a broader range of knowledge by encouraging discussion, clarifying ideas, and evaluating others' ideas. So and So and Brush (2008) and Biggs and Tang (2004) encourage interactive classrooms with learning facilitation, where students can have high-quality experiences with lecturers and receive real-time feedback. The benefits of blended learning activities for collaborative learning are captured in several studies (Ellis et al., 2016; Kirschner, 2001; Mshayisa, 2020; Osborne et al., 2018). Some studies suggest that the mere inclusion of blended learning activities will improve the engagement of students (Owston et al., 2013) and foster positive attitudes towards collaboration and satisfaction (So & Brush, 2008).

2 Research context

2.1 Theory of Change

Although blended learning has been reported in various disciplines such as nursing (Posey & Pintz, 2017), computer engineering (Yigit et al., 2014), language (Hassan Ja'ashan, 2015; Olivier, 2016), just to mention a few, no studies have been reported in food science and technology programs, especially from developing countries. Food science and technology is an interdisciplinary field in which the engineering, biological, and physical sciences are used to study the properties of foods, the principles underlying food processing, and the improvement of foods for the consuming public (Campbell-Platt, 2009). Therefore, this study aimed to investigate student perceptions of a collaborative and blended learning approach in a first-year food science and technology course at a large University of Technology (UoT). To achieve this, our primary research questions were:

1. What are student perceptions of blended learning?
2. What are student perceptions of collaborative learning?
3. What are student preferences on course format?

3 Learning context

The research was carried out in Cape Town, South Africa, at a larger public university of technology (UoT). A blended learning approach was introduced to first-year students (n= 133) enrolled in Food Technology 1 (FOT150S) in 2018. The 20-credit course contains both theoretical and practical elements.

There are no prerequisites for FOT150S, which is a foundation module in food science and technology curricula. In order to provide a basis for potential classes, the course takes a wide view of food production and its products. The majority of students who enrol for the course have no prior knowledge of food processing terminology. Gelatinization, viscosity, filtration, retrogradation, aseptic processing, blanching, fermentation technology, and sensory evaluation are all terms that these students are unfamiliar with. The course content and student-centred learning practices implemented in this study are housed on the course website (MyClassroom, Blackboard Inc., Washington, D.C., USA), an institutional learning management system (LMS) that supports collaborative and blended learning. Students could interact with the lecturer and with each other over discussion forums e.g. WhatsApp group for the module. Students had the opportunity to meet each other and the lecturer during weekly contact sessions that lasted 3.75 hours. In the introductory session, students received training on using Blackboard and obtained all the information required to work online. Students were expected to log on to the course individually whenever convenient, read that week's course material, download resources, and follow instructions to complete tasks. Fig. 1 exhibits the teaching and learning activities implemented in FOT150S as part of blended learning pedagogy. A description of the course activities undertaken in this module is provided below.

3.1 Teaching and learning activities in an undergraduate food technology module

Face-to-face classes

Interaction among students is necessary for successful learning activities such as developing problem-solving skills, critical higher-order thinking, and knowledge application, which reflect the types of skills needed in practice (Bates, 2015; Rocca et al., 2014; Shu & Gu, 2018). Face-to-face lectures still provide a meaningful and effective mode of supporting student learning (Thai et al., 2017), and this conjecture was endorsed by regular lecture attendance of between 70 - 80% of students. The face-to-face activities were designed to incorporate student-centred active learning practices. For example, student groups solved crossword puzzles to improve their food science and technology vocabulary and participated in class discussions. The lectures were supported by copies of the lecture

Figure 1: Online and face-to-face teaching and learning activities implemented in FOT150S

notes (as slides and handouts in PDF format) posted to the Blackboard site at least two weeks before the class time. The content was delivered using Microsoft PowerPoint presentations with infusions of multimedia and online tools such as Plickers or YouTube videos.

Tutorial sessions

Tutorials played a major role in integrating the teaching and learning activities with the assessment activities. Tutorial sessions (1.5-hour sessions) served to reinforce the material presented in lectures, provide a forum for students to gain assistance with progressive assessment and revision for examinations, and provide formative feedback on the progress examination. Tutorials were optional and attended by 55 - 70% of enrolled students, depending on the topics covered in the tutorial session.

Practical sessions

Food technology 1 (FOT150S) is a practical laboratory-focused discipline, and, as such, the practical component was an integral part of the module. During the first two practical sessions, the students were familiarised with all of the pilot plant equipment that they would later use during their practical sessions. Hygiene code of practice, laboratory conduct and pilot plant safety rules were also emphasised. These sessions include facilitators explaining the equipment, their functions, unit operations and use of the sensory evaluation facility. The equipment studied in detail includes those used to process bakery products, meat products, fermented foods, chocolate-based products and fruits and vegetables. During these sessions, the students were also exposed to the analytical equipment available to evaluate manufactured products. Instruments described and demonstrated include the refractometer, pH meter, colourimeter, viscometer, water activity meter and moisture analyser. Students were required to either watch a video (lecture prepared

screencast) or read a prepared note regarding the practical in addition to the practical manual. Screencasts were uploaded to YouTube as unlisted content and then shared via Blackboard by embedding the links. Students had a week before the practical session to familiarize themselves with the material in all of the materials, so the video links were triggered a week before the practical session. A pre-practical quiz on Blackboard was completed individually as a requirement for the practical to be conducted with the view to ensure adequate preparation and gauge understanding of the content. During practical sessions, students were placed in groups (6 students) to provide experience in building an effective team, sharing a workload, and dealing with team problems. The team organization facilitates overall learning, as many students learn by explaining concepts to their teammates and by having concepts explained to them by teammates. Following the Journal of Food Science manuscript submission format, a group practical report written as a scientific paper was then submitted on Blackboard, and formative feedback was provided using a rubric.

Team project

A group (6 students) assignment was given to the students in the form of a brief to come up with a product idea. Each group gave an oral presentation using a PowerPoint during a face-to-face session about their product idea incorporating essential concepts covered in face-to-face sessions such as unit operations, packaging and product shelf life. The lecturer and peers provided constructive feedback and had the opportunity to ask questions and comment on the presentations' strengths and weaknesses.

4 Data collection and analysis

A survey was administered via Blackboard at the end of the second semester. Students were informed that their grade for the course would not be affected by their participation, or lack thereof, in the survey, which was completely voluntary and anonymous. The unique, 23-item mixed-method survey instruments were created to elicit student responses. The first ten items identified the students' demographics and perceptions of the blended course. The next eight items identified the students' perception of collaborative learning, and the last two were multiple choice questions in the course format preferences. The surveys included two types of questions:

- quantitative questions including Likert scale ratings (5-point, "Strongly Agree"," Agree", "neither agree nor disagree", "Disagree", and "strongly disagree");
- respondents were provided with an opportunity to respond to open-ended questions about their study experiences, suggestions for improving learning enhancement activities, as well as their general comments related to the course. A total of 133 students were enrolled in the course, while 72.18% (n = 96) of the students completed the survey. All quantitative data were analysed using SPSS 25.0 (SPSS Inc., Chicago, Ill., U.S.A. 2017). The open-ended question responses were processed using Microsoft Excel® (2018) by selecting the frequently appearing responses and/or keywords in the responses to identify emerging themes. The internal reliability of the survey questions was measured by calculating Cronbach's Alpha (α) which was 0.84 and 0.92 for blended learning and collaborative learning questions, respectively. Since these Cronbach's alpha values suggest a high degree of internal consistency, the analysis presented in this paper can be considered accurate and relevant for obtaining student perceptions on blended and collaborative learning.

5 Results and discussion

5.1 Demographics

The online survey elicited students' responses to two demographic questions in order to provide context for the study findings. The breakdown of student profiles by demographics indicate that the participants were 24 and 74% male and female respectively (Fig. 2). The age of the respondents indicated that 34.4% were aged under

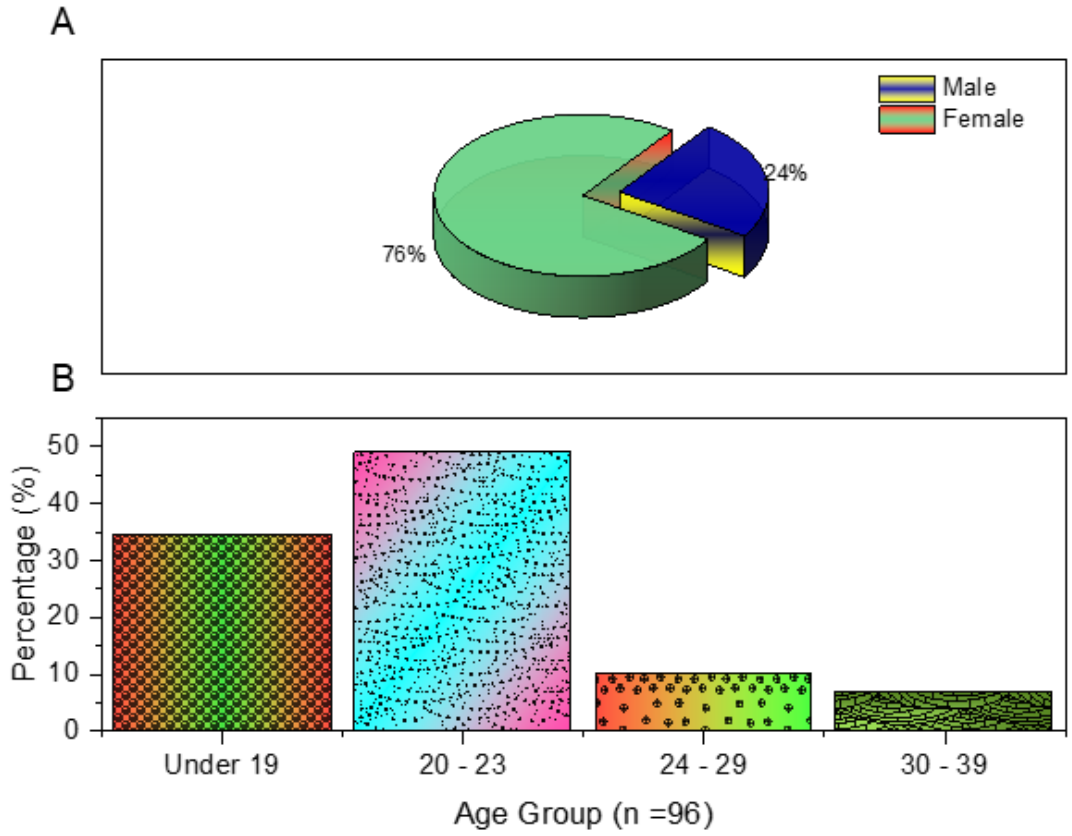

Figure 2: Student gender A) and age (B) demographics in FOT150S

19 years, 48.9% indicated 20 - 23 years, 10% indicated between 24 - 29 years while 6.7% indicated between 30 - 39 years old. Therefore, most of the respondents were aged between 20 - 23 years, exhibiting a young population regarded as more technologically savvy. All students participated in collaborative and blended learning activities implemented in FOT150S, and as a result, all of the respondents had the required experience to complete the questionnaire.

5.2 Students' perceptions of blended learning

The first research question aimed to elicit student responses to perceptions of the blended learning approach implemented in FOT150S. The student participants had no prior experience of blended learning at an institution of higher learning since these were primarily first-year students from high schools which are in predominantly underprivileged socio-economic environments characterized by the traditional chalk-and-talk approach. Learning is fostered under certain circumstances, including the motivational context and interaction with peers and lecturers. Evidence from the literature also suggests that it is imperative to be cognizant of the student's motivation to ensure student readiness and ability to cope with independent learning (Güzer & Caner, 2014). As shown in Fig. 3, a high percentage of the students felt that the course was inspir-

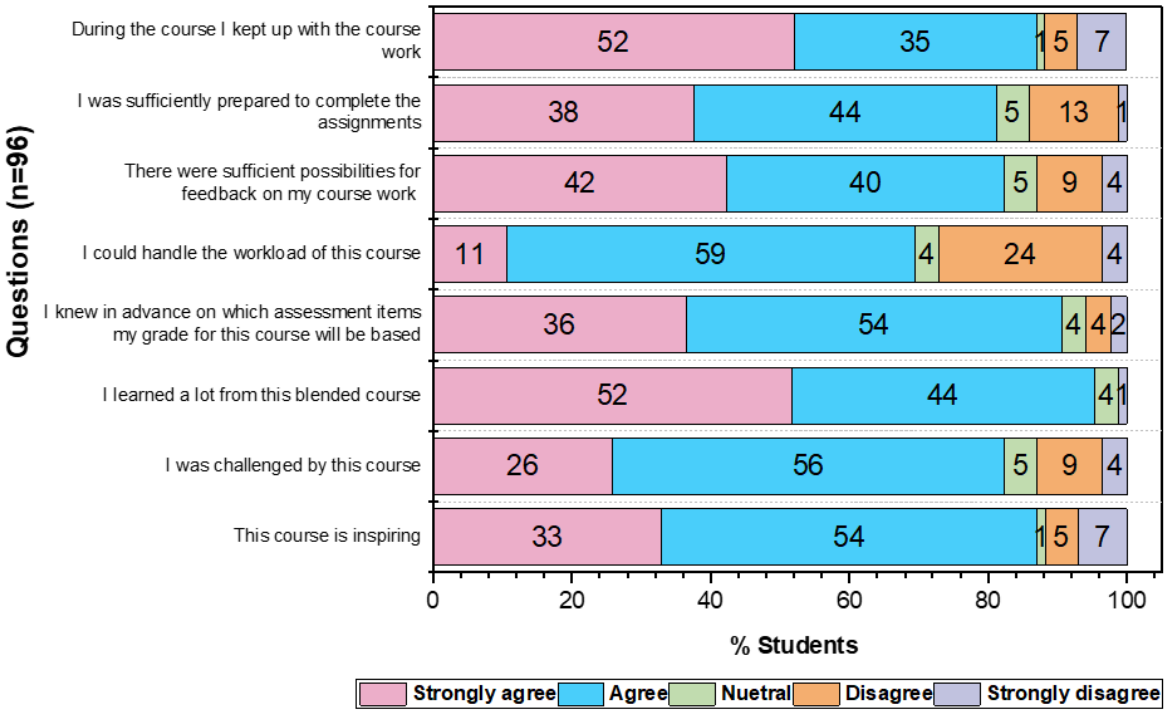

Figure 3: Students' perceptions of a blended food technology 1 (FOT150S) course

ing (Strongly Agree 38% and Agree 54%). For example, one student commented,

> I liked the fact that the lecturer made the subject very interesting and inspiring, especially when reflecting on real-life problems it made me look forward to participating in class.

Moreover, 70% of the students felt that they could handle the course workload, and 87% agreed that they could keep up with the course work. One student commented that

> There was a lot of work, but as time went by, I was able to manage my work through using the online course calendar and keeping up to date with required submissions.

It is essential to afford the students a reasonable workload to allow them to collaborate and independently learn outside the classroom. This is consistent with the findings of Mason et al. (2013), who reported that a blended learning approach allowed students to cover more content and increased opportunities for active and collaborative learning without adding to the students' overall workload.

However, these students perceived the course as challenging (82%), perhaps due to the technical content and the fact that they were in their first year of study. One student commented that

> FOT150S is becoming more challenging yet so educational, interactive and think on your feet to the extent that I am beginning to understand what food technology is all about.

This course required students to think critically and collaborate with others in a diverse setting to which they may not have been accustomed. Thus some may have found this learning approach challenging. Regarding preparedness to complete assignments, 82% of the students

agreed that they were prepared to complete the assignments, while 14% of the students disagreed with the same question (Fig. 3). One student noted,

> What I liked most about FOT150S was that we were provided with the best resources for us to study, pre-practical materials for example videos, crossword puzzles, etc. All these resources enabled me to prepare and complete the assignments.

These findings were positive, suggesting that students could learn at their own speed using their available tools. A blended learning approach had no adverse effect on their learning. These results are consistent with research showing that blended learning offers students flexibility (Yigit et al., 2014) as they had access to the content at any time, anywhere with Internet access from university or home. The students agreed that they knew in advance which assessment items on which their grades would be based (Fig. 3). This is attributed to the use of Blackboard as an effective LMS where students have an overview of their assessment due dates and the fact that they could access their study guide, which had the assessment weights on the same LMS. Students also commented that

> The way the LMS site is set out is helpful. You are given clear instructions on what is to be completed before each class and what is expected of you for practical sessions and assignments.

Perhaps the most welcome aspect of this module from the student perspective was the provision of varied, timely and relevant feedback, with frequent comments that it was the best feature of the FOT150S module. A large number (82%) of the participants agreed that they had sufficient possibilities for receiving feedback on their learning process (Fig. 3). For instance, one student discussed the benefits of receiving constant feedback from the instructor

> As a first-year student, it is important for you to know how well you are doing and what areas you need to improve on the lecturer feedback gave me confidence that I was following the correct study techniques to understand and apply the principles in food technology.

Students were given prompt feedback on their group assignments, group practical reports and individual learning journals via Blackboard. This technology-mediated approach ensured that the students always had access to the provided feedback at any time on the LMS to effect changes or improvements. According to Giacalone (2016), timely feedback can help students evaluate how they are performing.
Participants commented favourably that they learned more through this blended format (26% Strongly Agree and 56% Agree).

> I am obtaining more useful information through the videos, crossword puzzles, online quizzes, etc. They come in handy to my knowledge,

one student commented. These findings concur with studies that suggested that blended learning increased student knowledge, collaboration skills, performance and confidence (Gill, 2009; Kavadella et al., 2012; Kuhn et al., 2018). What makes blended learning particularly effective in food science and technology is its ability to facilitate a community of inquiry and collaboration. The student ceases to be a passive element and develops critical competencies such as selecting information, teamwork, critical thinking, and self-management of the learning process.
Moreover, students must apply and use in practice what they have learned. This would support the notion of constructivism guided by Piaget and Vygotsky (Smyth et al., 2012). In constructivist learning, students build up their own body of knowledge centred on individual experiences and then apply this knowledge directly to the setting. This research provides empirical evidence that complements previous findings on blended learning in higher education (De la Flor López et al., 2016; López-Pérez et al., 2011; Trujillo Maza et al., 2016).

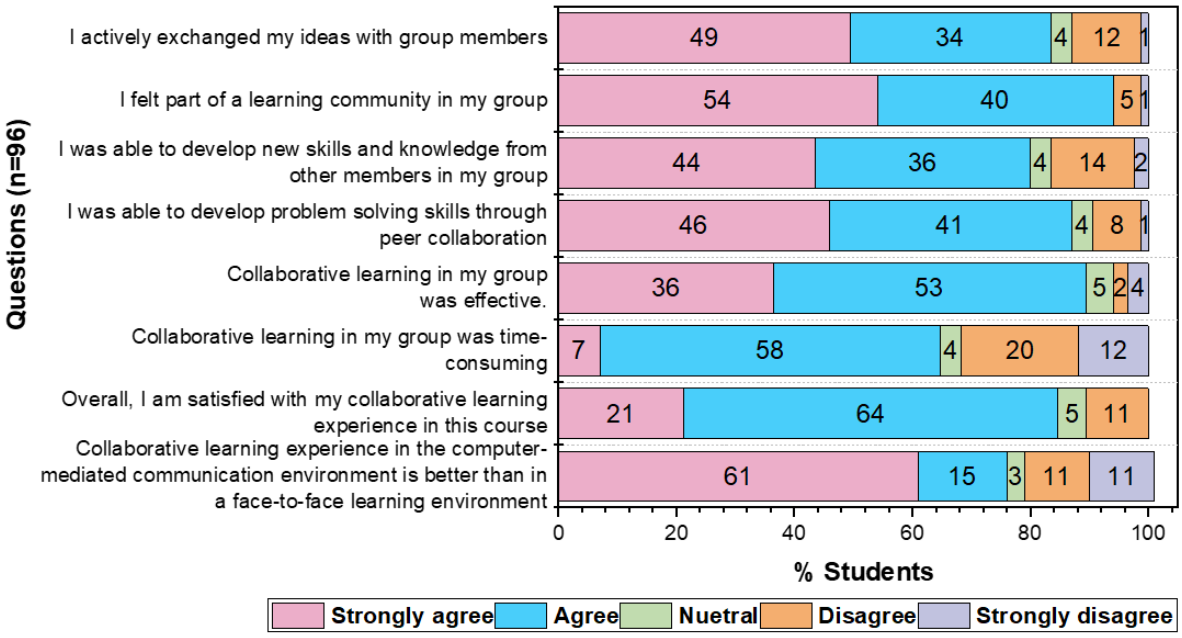

Figure 4: Students' perceptions of collaborative learning in Food Technology 1 (FOT150S) course

5.3 Collaborative learning

Active learning techniques support higher education goals and objectives specifically through familiarizing the students with diverse ways of knowing, fostering cross-disciplinary interactions and exposure to differing viewpoints. The large class size (> 80) provides an ideal setting to test the activities with a diverse student population, particularly given that the students in food science and technology will be required to work in diverse groups to produce a food product as part of an integrated module in the first year of study. The use of various teaching techniques in this cross-disciplinary course capitalizes on the cultural diversity of student experiences and ways of knowing. The course activities studied ranged from the common, in-class group discussions, group food production practicals and report writing, group assignments, and individual web-based reporting (quizzes), to the not-so-common in food science and technology, academic journal reflections.

Therefore, the second research question was to investigate the students' perceptions of collaborative learning in the course offered in a blended learning approach. The results obtained after administering the questionnaire were generally positive as many (84%) of the students felt that the collaborative learning experience in the blended learning environment is better than the traditional face-to-face learning environment (Fig. 4). This can be attributed to social media applications such as WhatsApp and the group tools in the Blackboard learning management system which the students utilised. In FOT150S, the students used WhatsApp extensively to facilitate communication, collaboration, scheduling meetings, and sharing and discussing food science and technology-related information. This is in line with the studies of Gachago et al. (2017) and (Owston et al., 2013) who observed that social media apps such as WhatsApp can be used to complement blended learning and facilitate student learning.

Moreover, collaborative learning activities led to

more interactions among students as more than 90% of the participants felt part of a learning community, actively exchanged ideas (83%), developed new skills (80%) and were able to develop problem-solving skills through peer collaboration (87%) (Fig. 4). One student commented,

> What I enjoyed the most about this course was the group activities. It was challenging but yet fun, and yet it is meaningful to work with others. I always learn something new.

Combining online activities and learning resources with synchronous discussions may have encouraged participation and facilitated greater flexibility in learning than before, through opportunities for interaction with content and peers prior to, during, and after face-to-face classes. This approach may have been particularly valuable among students with different learning styles. In collaborative learning, the students are responsible for their own and the group's learning. The respondents were satisfied with the overall collaborative learning experience FOT150S offered using the blended learning approach. In this study, 94% of the students reported having felt as part of a learning community. One student noted,

> I learned a lot from my group members, it was helpful to bounce ideas with them even if it is just to validate your ideas.

It is vital to communicate with others to build a culture of inquiry characterized by reflective written or spontaneous verbal discourse. This module also offered the students the opportunity to communicate with one another, and one student noted,

> ... module is the way we interacted with one another in class because of the groups that we had been allocated. The discussions we engaged in were also interesting and eye-opening, allowed us to polish our communication skills and most of all educating.

According to Garrison and Kanuka (2004), a sense of community is also necessary to sustain the educational experience over time, so essential to moving students to higher levels of thinking. This is important as students with a stronger sense of community tend to possess greater perceived levels of cognitive learning.
The students' ability to systematically and methodically think and solve problems improved. For example, the first practical session was very chaotic because students were not prepared and had not worked in groups before. Many students had neglected to bring a copy of their practical manual, and they had trouble interacting with one another. The use of pre-practical online tests later eliminated this as students were compelled to read or watch online videos posted on Blackboard before coming to the sessions either as individuals or as groups. This study confirms the results obtained by Gregory and Di Trapani (2012). There is a lack of information about students' perceptions of blended and collaborative learning from a food science and technology point of view in the current literature. The present study addresses this gap by exploring a blended and collaborative approach to undergraduate perceptions.

5.4 Student preferences on course format

To further probe student preferences on the blended learning pedagogy, two Multiple Choice Questions (MCQ) were asked pertaining to class attendance and course format, respectively. The first MCQ aimed to elicit student preferences on class attendance format (Fig. 5). In this study, 14% of the students preferred only accessing online downloadable videos of lectures, while 26% preferred attending face-to-face. Interestingly, 60% of the respondents preferred a combination of both - a blended learning approach. The blended learning approach allows students to access online components whenever and wherever they prefer while also having personal contact with peers and instructors (Poon, 2013). The second MCQ focused on the respondents preferred course format (Fig. 6). In this study, 10% of the students preferred to have the course offered entirely online, while 58% preferred the blended course format.

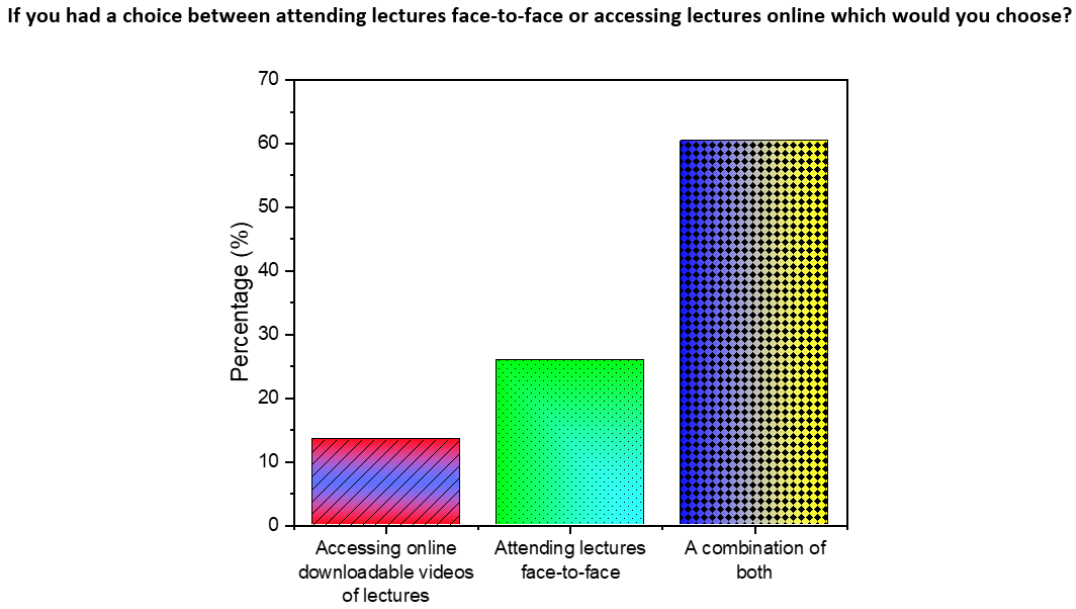

Figure 5: Student preferences on course attendance

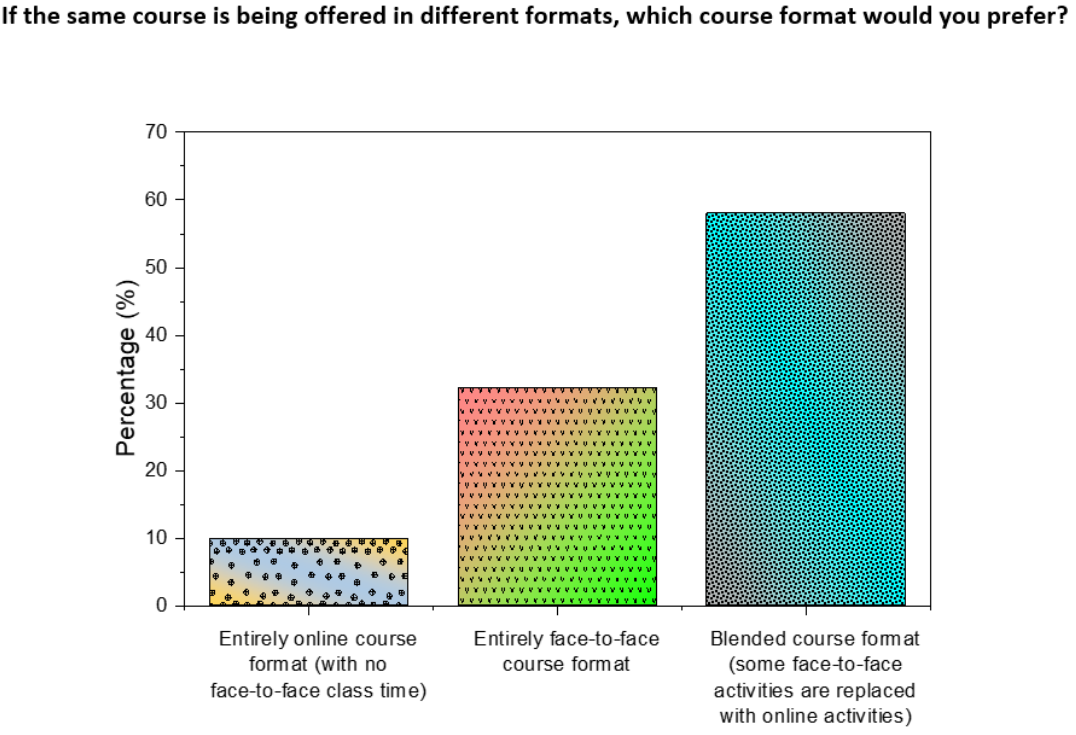

Figure 6: Student preferences on course format

> Frequent meetings with peers and lecturers in class helped to build a powerful personal learning network,

one student said.
Students have expressed a preference for posing their questions directly to the instructor in class. These students found the mix of face-to-face and online mode is beneficial for their learning experiences. On the whole, students with a preference for the blended mode value the freedom of choice as regards the ways of learning. According to Waha and Davis (2014), the most common factors that cause students to prefer a blended learning mode are flexibility, convenience, interaction with peers and lecturers, interaction, independence, and balancing work commitments. The results of this study illustrate the importance of educating food science and technology students using an amalgamation of instructional modalities.

5.5 Themes emerging from student responses to open-ended questions

In addition to responding to Likert-scale questions, students also wrote in comments in response to the open-ended questions: 'What did you like best or least about FOT150S?' A representative selection of comprehensive responses showing different themes of students' perspectives is depicted in Table 1. Peer-learning/instructions, communication, self-directed learning and self-monitoring of learning progress were the most predominant themes cited by the students in terms of the benefits of this pedagogical approach. These voluntary comments were generally very positive and showed that the students have an appetite for a blended and collaborative learning environment. The results of the student perception surveys highlighted the importance of educating food science and technology students using a combination of instructional modalities. According to the results, blended learning is appropriate and favoured by students in the field of food science and technology. Today's students readily accept new technology and quickly learn how to use, navigate, and handle it (Hubackova & Semradova, 2016). Eliciting student feedback or perceptions of the course is vital to improving course delivery. Student satisfaction is imperative and needs to be continuously assessed to assure students' quality of learning experiences. Satisfied students are more motivated (Shantakumari & Sajith, 2014) and committed and hence better learners than their dissatisfied counterparts. In order to ensure that high-quality learning is achieved in a situation where their instructor and students are physically separated, research on student satisfaction with blended learning is required. As revealed in the open-ended questions, a blended approach which included: pre-practical online test, crossword puzzles and screencasts designed by the lecturer, was well received by the students.

6 Limitations of the study

There are a few limitations of this study to note. The absence of a comparator group is a limitation of the cross-sectional design, as there were no earlier or concurrent studies of students' experiences or perceptions of the traditional teaching modalities of the course. It is also worth noting that all of the findings were related to better learning to improved learning, and the effectiveness of learning are based on students self-declared perceptions and not on independent measures.

7 Conclusion

This study illustrates students' satisfaction with blended learning in food science and technology as it offers them more flexibility, which allows them to collaborate and independently learn outside the classroom. Moreover, this reflects the interaction between instructors, the content and peers and gives them enough time to do their tasks. So, students are encouraged to take responsibility for their own learning process and learners can decide when and how to use the resources provided. In the blended model, students' preference for individual and independent learning was discovered to be an advantage. The findings of this study, in general, support the

Table 1: Themes that emerged from the open-ended questions on students perceptions of the blended FOT150s course

Themes	Illustrative quotes
Benefits	
Critical thinking	"The assessment in FOT150s challenges you to apply your knowledge through the use of cases...I liked the fact that I had to apply the concepts that I have been learning".
Peer-learning	"Each team member brought a unique strength to the group that helped make our practical reports successful".
Communication	"Communication through WhatsApp is very useful because if you don't understand something, then you can ask for help, and you will be assisted very quickly."
Self-directed learning	"I always look forward to doing the practicals in the pilot plant because of the pre-practical videos, which were interesting and made me research more about the practical". ".
Self-monitoring of learning progress	"Using online learning Journals, we can easily monitor and track our learning progress. I can clearly see what I have learnt before and the way until now. I can see the progression of my learning".
Drawbacks/suggestions	
Practical sessions	"The long hours of practicals and there are no breaks even in between the hours of the practical labour by the time you go home you are worn out."
Learning styles	"I think there should be more videos because it is easier to understand something that you can see".
Tutor	'I think it would be better for everyone if we got a new tutor or another one to assist the one that we already have, and we need more of those videos".
Internet connectivity	"Since I don't have the internet at home, it was very challenging to do some of the online stuff, especially if the IT centre was closed or full".

benefits of integrating blended and collaborative learning into food science and technology curricula. Future research could use qualitative research methods, including interviews or focus groups, to better understand the complexities of students' perspectives on blended learning. This would allow researchers to investigate factors that might improve their engagement.

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