

MILAGE LEARN+: Motivation and Grade Benefits in Computer Science University Students

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Abstract—This innovative practice full paper describes an experience of using MILAGE LEARN+ with Computer Science university students. Students motivation when in an academic setting is a very important aspect of how well they will learn the material provided. Many computer science students own smart phones, tablets, and computers in order to complete their work and study. Here we introduce MILAGE LEARN+ to fourth year computer science university students. MILAGE LEARN+ is a mobile educational application where students take quizzes, watch videos, and do assignments in worksheet format. This application integrates the gamification pedagogy with the usage of difficulty levels, a leader board, as well as self and peer-review in order to benefit students' motivation, autonomy, and their grades. While MILAGE LEARN+ has been used in many European countries with a variety of age groups and fields of study there has been no research done on how American students connect with the application. In this study we are examining how university students in computer science react to the usage of this application. MILAGE LEARN+ was integrated into a 400-level computer science course at a Research 1, land-grant university, for the usage of quiz taking. We have focused on usage of the leader board, peer-review, and self-review to answer the following questions: How does MILAGE LEARN+ affect students' motivation? Does it benefit their grades? And is it an overall positive experience for our students? Participation in this study was entirely voluntary and those who chose not to participate were given an alternative assignment using Canvas quizzes. The study was reviewed and approved by the IRB committee of our University. There were 38 students participating in this study. All of these students are majoring in computer science or engineering equivalent course. Students had four weeks to take a series of ten quizzes. These quizzes covered content covered in class and were worth ten points on each quiz. Most of the quizzes had five questions worth two points each with a select few having ten questions worth one point each. The quizzes contained a variety of answering styles including: multiple choice, true/false, and free response through the keyboard. We compared these quizzes to an exam on Canvas LMS. The Canvas exam had all of the same questions as provided in the MILAGE LEARN+ quizzes. These response styles were also a mix of multiple choice, true/false, and free response through the keyboard. Student users later evaluated the application and quizzes through electronic survey. The survey included 15 questions, 12 of which were answers based on the Likert-type scale. MILAGE LEARN+ was shown to have a higher percentage of students get a question correct on the quizzes in comparison to those using the Canvas learning management system. Though, MILAGE LEARN+ students were also shown to have issues with the application. While there were some limitations with our study, our results were statistically significant and shown that MILAGE

LEARN+ does in fact boost students' grades, even if they encounter difficulties with using the application.

Keywords—higher education, undergraduate, pedagogical and instructional approaches, student assessment, gamification

I. INTRODUCTION

Students motivation when in an academic setting is a very important aspect of how well they will learn the material provided. Many college students also like the ability to be independent and autonomous, without too much needed from their professors or advisors [1]. MILAGE LEARN+ is a mobile educational application where students take quizzes, watch videos, and do assignments in worksheet format. This application integrates the gamification pedagogy with the usage of difficulty levels, a leader board, as well as self and peer-review in order to benefit students motivation, autonomy, and benefit their grades. MILAGE LEARN+ was originally presented in Portugal for improving the learning of mathematics taking advantage of gamification to motivate students and the self and peer assessment scheme to promote autonomy of students [2]. It is now used in different subjects amongst different age groups [3].

MILAGE LEARN+ provides students with worksheets that are available away from the classroom. This allows them to continue their education outside of traditional learning experiences, and in their own time. Worksheets have many different types of questions including: true/false, free response, and multiple choice. Free response questions can be submitted by keyboard or camera. By allowing students to submit through camera usage, they can take pictures not only of their final answers, but also of their work. Once students submit a free response question they are prompted to grade themselves based on the instructor provided video tutorial and/or provided solution image. Once a student has submitted an answer and graded themselves, anonymous peer reviewing takes place where students grade other students solutions. This allows students to see their own solution, a teacher provided solution, and other peers solutions.

In this way, students self-regulate, become more autonomous and can reflect on their peers finding new ways to solve problems [2-4].

A. What we did

While MILAGE LEARN+ has been used in many European countries with a variety of age groups and fields of study[3,4]

there has been no study done on how American students connect with the application. In this study we are examining how university students in computer science react to the usage of this application. MILAGE LEARN+ was integrated into a 400-level computer science course at a Research 1, land-grant university, for the usage of quiz taking. We have focused on usage of the leader board, peer-review, and self-review. How does MILAGE LEARN+ affect students motivation? Does it benefit their grades? And is it an overall positive experience for our students?

II. LITERATURE REVIEW AND RELATED WORKS

A. Student Grades

Student grades in academia has always been a very interesting topic, as grades tell how well a student is doing in a course. Grades are commonly letters associated with a particular scoring in the course as a whole, and they have a massive effect on how students view themselves as well as the course they are taking. But how do grades motivate students to do well in their courses?

Grades are a big determination if a student is motivated or not, as they influence feelings of autonomy, competence, and relatedness in many ways. Lower than expected or lower than wanted grades could deter students from wanting to learn new information about a certain topic [5]. Many students feel that grades are similar to consumer-seller relationship as the instructors provide grades in turn for students tuition [5]. This is less than ideal, as many instructors do want their students to do well. They want the students who are struggling the most in class to also have the most motivation in order to bring themselves higher up in the course. While grades have been shown to influence in motivation, there has been evidence to show that external motivators play an even bigger role [5]. External pressures create an environment where grades become so important therefore motivating students to put in a lot of effort. Parents, competitive programs, scholarships, etcetera... play a role in students motivation to get good grades.

Grades have and always will be a source of anxiety and stress whether that stress is coming from internally or externally. Students need an environment where grades are not the only motivator, but they have more motivation because they are having fun in their learning processes [6]. This is where different pedagogies including gamification, can come in and make a difference on improving students motivation and therefore improving their grades.

B. Gamification Pedagogy

Nowadays, there are many different applications that incorporate the idea of gamification in order to benefit student's learning. Kahoot! and Quizlet [7] are just a few of the most widely used and most popular applications. These applications include music, images, leader boards, and more that lead them to be gamified. Traits such as these cause students to feel as though they are purely playing a game, instead of learning.

Schools in Indonesia participated in a research study on the effects of integrating the learning tool Kahoot! into everyday learning. This study showed that competitiveness is proven to affect students motivation, as seen when a majority of the students participating stated that they wanted to achieve the

highest rank in Kahoot! [6, 7]. These findings are in alignment with many other studies that show gamification produces an exciting and interactive learning process [8]. It was also found that the reward system implemented throughout these gamified applications plays a major role in increasing students motivation [9]. Lastly, gamification methods have also been proven to positively affect higher education students motivation as well, if students are willing to participate. One study found that, in higher education, while gamification does get some population of the classroom active and motivated, it also alienates others [10].

Gamification is a growing factor in many different learning applications in order to allow students to have a more positive form of external motivation. For some groups gamification works very well, but for others the experience is alienating and presents a negative impact on their motivation to learn [11].

C. MILAGE LEARN+

MILAGE LEARN+ is a new and upcoming mobile application that incorporates grades, gamification, and flexibility. This allows students to get multiple types of motivation, while making it fun and flexible.

MILAGE LEARN+ allows students to grade themselves and their peers allowing them to learn more by seeing many possible solutions. This lowers their stress levels when it comes to grades thus increasing their motivation. Allowing students to grade themselves helps them fully understand why their grade is as high or low as it is shown to be and how to improve their work in the future [3]. Leader boards and difficulty levels add to the gamification of the application. Motivation through competition is available through the leader boards which are based on the number of points you have in the course. The leader board is anonymous as students can create nicknames to know where they sit on the leader board, without seeing where anyone else is on the leader board. Anonymity prevents the alienation of students who do not want to participate in the competition [4]. Having the application on a mobile device allows students to be flexible with their learning inside and outside of the classroom. This continuous learning was shown to have a positive effect on students grades, as they could do worksheets, take quizzes, or watch videos wherever and whenever they liked [12].

Overall MILAGE LEARN+ incorporates all of the positive aspects instructors look for in a learning application. It allows students to work outside of class, on the go, as well as internal and external motivation [13].

III. METHODOLOGY

A. Participants

Participation in this study is entirely voluntary and those who chose not to participate were given an alternative assignment. The alternative assignment contains the exactly same quizzes, but without the gamification component. Participants are being drawn from a 400 level Computer Science Object-Oriented Design course. There are 38 fourth year, and above, computer science students participating in this study. All of these students are majoring in computer science or engineering equivalent with a mix of undergraduate and graduate level students. These students are all over the age of 18. Students range in ethnicity,

backgrounds, and age, their exact personal information was not collected for the purposes of this study.

B. Experimental Design and Materials

Students had four weeks to take a series of ten quizzes. These quizzes covered content studied in class and were worth ten points on each quiz. Most of the quizzes had five questions worth two points each with a select few having ten questions worth one point each. The quizzes contained a variety of answering styles including: multiple choice, true/false, and free response through the keyboard.

We are comparing these quizzes to an exam on Canvas LMS. The Canvas exam had all of the same questions as provided in the MILAGE LEARN+ quizzes. These response styles were also a mix of multiple choice, true/false, and free response through the keyboard.

- **Gamification.** The main mode of gamification implemented in this study was the leader board, though we did not incorporate the multiple difficulty levels for quizzes. Students were made aware that the leader board did exist, but were not pressured or required to view the leader board at all. There was also no mention of the leader board through any form of communication.
- **Self and Peer Assessment.** In order to get a grade on many questions throughout the ten quizzes, students were required to participate in self-assessment. There were many free response questions where, once a student submitted an answer, they were required to grade themselves in order to get more than zero points on the question. We encouraged students to participate in the peer assessment portion of MILAGE LEARN+, but there was no requirement or grade associated with completing the peer assessment.
- **Mobile Learning.** Students were encouraged to download MILAGE LEARN+ on their mobile devices such as phones or tablets. While many students did download the application on their mobile devices, there were some that were "uncomfortable" having the application on their phone.
- **Survey.** Once the quiz taking was completed, students were asked to fill out a survey answering questions about their experience with the application. This survey consisted of two questions about how often they used the application or viewed the leader board, twelve Likert-scale type questions about their overall experience with the application, and one free response question where students were encouraged to leave extra thoughts and feelings not commented on previously. The following were the questions provided:

- (1) On average I used MILAGE LEARN+ for:
 - (a) Less than one hour a week
 - (b) 1 hour a week
 - (c) 2 hours a week
 - (d) 3 hours a week
 - (e) 4 hours a week
 - (f) 5+ hours a week

- (2) I viewed the leader board:

- (a) Once
- (b) Twice
- (c) Three times
- (d) Four times
- (e) 5+ times

- (3) On a scale of 1 to 5 (1 being strongly disagree and 5 being strongly agree) please answer the following:

- (a) My level of frustration while using MILAGE LEARN+ was minimal to none.
- (b) The existence of a leader board score was motivating.
- (c) The existence of a leader board score was negatively impacting my ability to learn.
- (d) Self-assessment tasks help me understand the solution.
- (e) Peer assessment tasks help me understand the solution.
- (f) Point results are important.
- (g) I enjoyed taking quizzes using MILAGE LEARN+.
- (h) I prefer quiz taking in Canvas compared to MILAGE LEARN+.
- (i) I would use this tool again in the future.
- (j) Using this tool could have benefited me in the past.
- (k) Using this tool was an overall positive experience.
- (l) Using this tool was an overall negative experience.

- (4) If there is anything else you would like to tell us about your experience using MILAGE LEARN+ please write it here:

IV. RESULTS

A. Grades

We compared Canvas and MILAGE LEARN+ by looking at the percentage of students who got the question right, both on Canvas and on MILAGE LEARN+. The Canvas data was pulled from a previous semester's final exam that consisted of the same questions as the ten MILAGE LEARN+ quizzes.

These quizzes were hand graded as there was not yet an available way for us to download MILAGE LEARN+ grades. This allowed us to not only give students points if they graded themselves too harshly on the self-assessment, but it also allowed us to fix grades if they were giving themselves full credit on every self-assessment even if they got the question wrong.

Figure 1 shows the comparison of Canvas and MILAGE LEARN+ quizzes by looking at each individual question for quizzes 1 through 5. For each question we see the percentage of students who got that question right on both MILAGE LEARN+ (Yellow) and Canvas (Blue). Some notable differences in quizzes 1 through 5 can be seen in Figure 1 question 6, question 13, and question 25. On question 6, 10% of Canvas students answered the question correctly while 79% of MILAGE LEARN+ students answered the same question correctly. Similarly question 13, 4% of Canvas students answered it

correctly and 26% of MILAGE LEARN+ students answered the question correctly. Finally, question 25 17% of Canvas students got the correct answer while 47% of MILAGE LEARN+ students got the correct answer. There were only 2 questions out of 25 where Canvas students had a higher percentage of students getting those questions right. Shown in Figure 1 these are questions 3 and 8.

Throughout the 25 questions in quizzes 1 through 5, students using MILAGE LEARN+ had on average 78% of students answering questions correctly. This is in comparison to Canvas where, on the same set of questions, on average 49% of students were answering questions correctly. With a higher percent of

students answer questions correctly in MILAGE LEARN+, it is increasing their grades. MILAGE LEARN+ is, so far, showing to positively impact students grades.

Figure 2 shows the same comparison of Canvas and MILAGE LEARN+ quizzes as Figure 1, but now focusing on Quizzes 6 through 10. For each question we see the percentage of students who got that question right on both MILAGE LEARN+ (Yellow) and Canvas (Blue). On 6 questions out of the 30 in this section, Canvas students had a larger percentage of students get the correct answer than in MILAGE LEARN+.

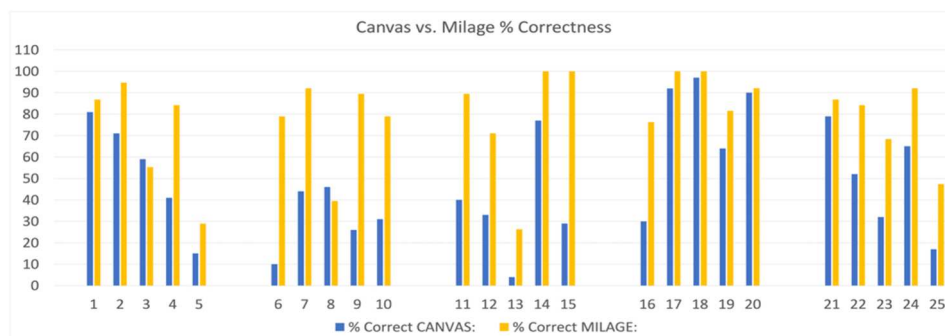


Fig. 1. Percentage of students to get a question correct in Canvas and MILAGE LEARN+ (Quizzes 1 through 5)

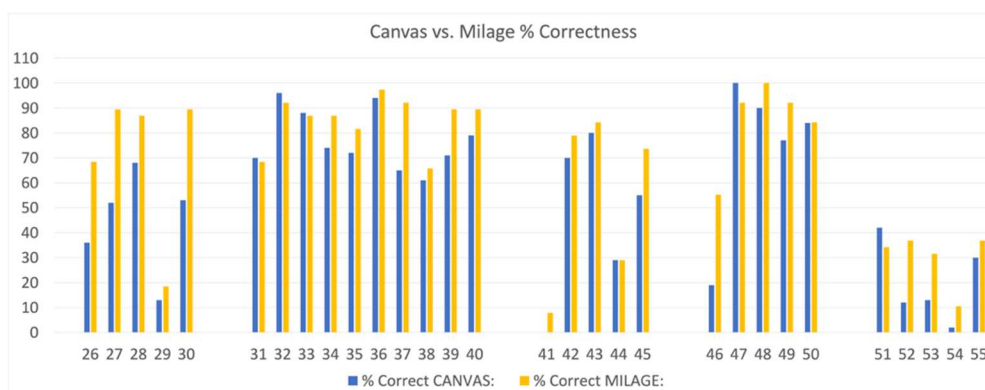


Fig. 2. Percentage of students to get a question correct in Canvas and MILAGE LEARN+ (Quizzes 6 through 10)

Out of the 8 questions that Canvas had a higher percentage on, only two questions had close to a 10 percent correctness difference. On questions 47 and 51 (Figure 2), Canvas had an 8% higher correctness than MILAGE LEARN+.

B. Feelings and Motivation

The survey provided in the Survey subsection of this paper was used in order to collect data about students thoughts and feelings on MILAGE LEARN+. Questions focused on their experiences within the application and how they felt about individual interactions. Out of the 38 total students using MILAGE LEARN+ there were 32 that completed the survey.

On average students used MILAGE LEARN+ for between 1 and 2 hours per week, with the majority of students using MILAGE LEARN+ for closer to 2 hours per week (Figure 3.).

Throughout the time spent using MILAGE LEARN+ a majority of students stated that they only viewed the leader board once, when it was initially shown in class.

A very small percentage of students viewed the leader board twice, with no students viewing the leader board more than twice (Figure 4.). With the leader board being a large factor when it comes to increasing student's motivation, this data was less than ideal. Many students stated they had a hard time finding the leader board or no data was shown on the leader board, if they had found it.

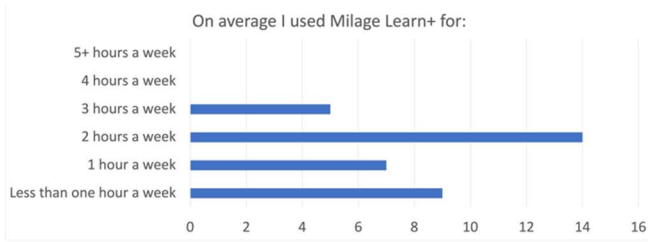


Fig. 3. Weekly hours students spent using MILAGE LEARN+

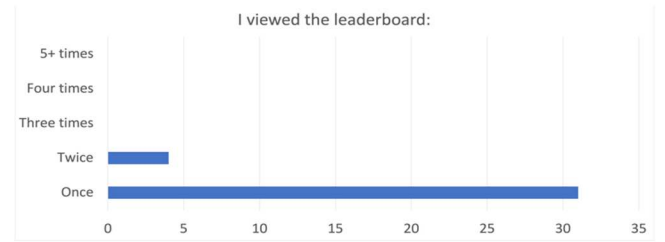


Fig. 4. How many total times students viewed the MILAGE LEARN+ leaderboard

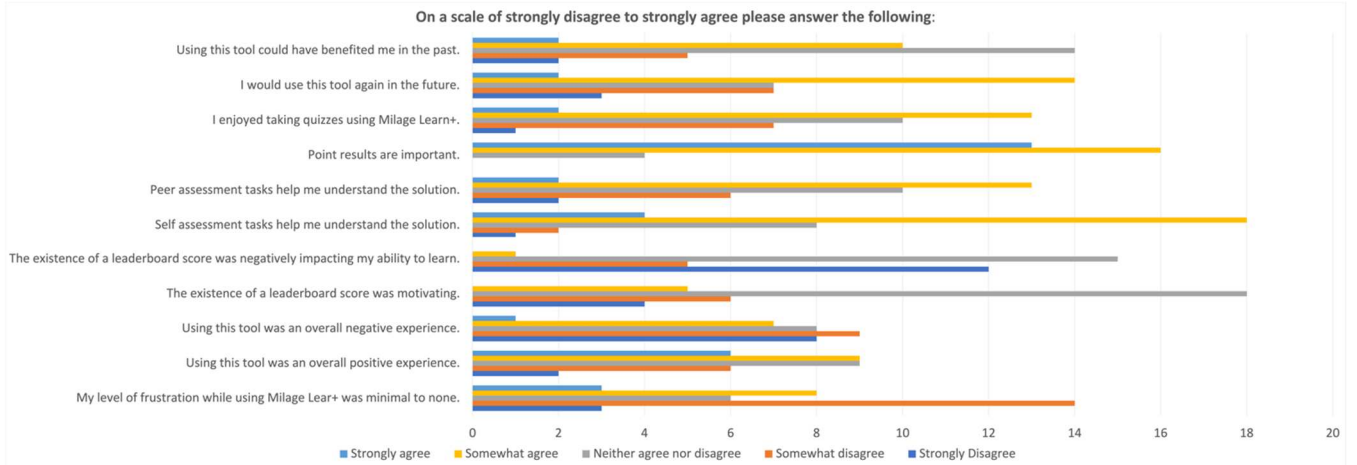


Fig. 5. Student's responses to Likert-type questions about their feelings on MILAGE LEARN+

The next section of the survey focuses more on students feelings and experiences within the application. Firstly, 44% students stated they became frustrated with the MILAGE LEARN+ application (Figure 5.). The most common answer to the question "My level of frustration while using MILAGE LEARN+ was minimal to none" was 'Somewhat disagree' meaning a majority of students felt frustrated for some period of time while using the application.

Students were spread out when answering these next two questions. Many students felt indifferent about their overall experience with the application with 'Neither agree nor disagree' being the most common answer for both "Using this tool was an overall positive experience." as well as "Using this tool was an overall negative experience" (Figure 5.). But there were 47% of students that agreed that using MILAGE LEARN+ was an overall positive experience and 50% stating that it was not, a negative experience.

As many students were unable to view the leader board on their own time, 53% of students felt indifferent towards the leader board. Since there were issues finding the leader board, there seemed to be no positive or negative feelings from students.

Self and peer assessment tasks were similarly rated with 66% of students stating that they 'agree' or 'somewhat agree' that self and peer assessment tasks helped them understand the solution. Additionally, 84% of students somewhat or strongly agreed that point results are important (Figure 5). 47% of students enjoyed

quiz taking in MILAGE LEARN+. This same percentage stated that they would use this tool in the future (Figure 5). Finally, 44% of students again felt indifferent to the tool stating that they 'Neither agree(d) nor disagree(d)' that the tool could've helped them in the past.

V. DISCUSSION

A. Grades

Overall, MILAGE LEARN+ students did better than Canvas students on 47 out of the 55 available questions. There were few questions where Canvas students had a higher percentage of correct answers, but on only 8 out of 55 questions. This shows that MILAGE LEARN+ does have a positive effect on student's grades as more MILAGE LEARN+ students got higher grades than those students using Canvas considering the data analyzed. Figure 1 and Figure 2 show the differences between Canvas and MILAGE LEARN+ when it comes to the percentage of students who got that question right.

It was surprising to see that Canvas students did marginally better than MILAGE LEARN+ students when it came to the 8 questions Canvas had a higher percentage of students get correct. This was in comparison to the many questions where MILAGE LEARN+ students did significantly better than Canvas students. These results were very exciting to see as our hypothesis was that MILAGE LEARN+ students would do better than Canvas, but we had not considered that it would be at this considerable scale.

We were expecting to see that MILAGE LEARN+ students had better scores than those using Canvas, which in the end was the correct hypothesis. Since the resulting data had a normal distribution, we used Microsoft Excel's provided t-Test: Two-Sample Assuming Unequal Variances' in order to calculate our resulting p-value. When calculating if these findings were statistically significant, the resulting p value was $p=0.00014$ which is statistically significant.

B. Feelings and Motivation

We used the new MILAGE LEARN+ 2.0, which was in beta version available for iOS and Android, and because of this there were some bugs in the application such as changing students responses on submission, changing languages on buttons, operating system issues, the application crashed for some students, and others struggled to find the leader board. All of these issues became very frustrating for students.

Majority of students who used MILAGE LEARN+, complained about the application changing their answers after submission, causing them to get that question incorrect. Most of these students experienced this issue when answering true/false questions. Aside from comments seen in Figure 6. many

students reached out to the Teaching Assistant (TA) privately about this issue in order to get their final grade fixed.

Additionally many students also had issues with the technology they were using to run the app. While all students participating in this study had the correct version of the application, there were many struggling with seeing PDFs, viewing quizzes in a landscape view, or the application would purely not load on their older device. Some attempted to use the Microsoft Windows version of the application, and many of these students ended up needing to find a new device to run the application on as there was not a working Microsoft Windows version of the application available.

Three students had issues with their apple IOS devices, one commenting "I found a weird bug on IOS where the formatting of any page breaks when you leave the app and go back into the app. Menus disappear when this happens, and the only way to resolve this is to restart the entire application." (Figure 6.) Another commented "The app on my MacBook Pro crashed and quit unexpectedly six times while taking the quizzes" (Figure 6.). With these issues came increased frustration levels for these students, which may have inhibited their motivation rather than increased it.

If there is anything else you would like to tell us about your experience using Milage Learn+ please let us know by writing it here:
mobile only was not conducive to learning. Ratings would be better if there was a PC version
Pretty buggy, the UI was laggy, other than that pretty cool
There were a few questions, specifically true and false that had some issues with changing your answer, and switching between questions on some quizzes would sometimes result in questions being out of order leading to "wrong" answers, but other than it was a good experience.
I experienced a few bugs such as wrong input in some questions due to app performance, causing incorrect results.
The app gave false reports on if a true/false question was answered correctly. However being able to hop in and out was good!
The app on my MacBook Pro crashed and quit unexpectedly six times while taking the quizzes. Also, for True/False questions, it appeared that the app had a bug in displaying the answers/results.
The app was fine, there was an issue where it would log a different answer than I selected though which definitely hampered the experience.
I couldn't find the leaderboard. Also, I lost points for questions I answered correctly.
A bit unfortunate that Windows users had to use Mobile phones, but understandable as it's a newer product. There were also some mistakes, particularly with true/false questions.
I couldn't find the leader board for some reason
I found a weird bug on IOS where the formatting of any page breaks when you leave the app and go back into the app. Menus disappear when this happens, and the only way to resolve this is to restart the entire application.
I never was able to find the leaderboard mentioned in this survey.
App is super hard to use on an iPad on its side. You can't easily see all the buttons, textboxes, and solutions when the keyboard is open

Fig. 6. Student's responses to open ended question

Also, as seen in Figure 6., many students struggled to find the leader board. Other students reached out privately and said that even though they found the leader board there was no data being shown. This also caused issues as this was supposed to be a large factor at increasing students motivation.

Finally, aside from some issues with the application many students wrote comments that they enjoyed the flexibility of the application. Being able to "hop in and out was good!" (Figure 6.). The ability to switch to different quizzes or leave the quizzes completely and come back later without losing answers or data was a big positive in many students minds. Other students reached out privately and stated that they would like to see the application updated before they use it again. While there were issues within the application that cause frustration, students seemed to enjoy their overall experience in the end.

C. Limitations

While the results showed that MILAGE LEARN+ could boost student's grades, even though some experienced issues with the application, there were some events that could have impacted the results of this study. Firstly, MILAGE LEARN+

offers many different features for boosting students grades and motivation. For the purpose of this research we only focused on two of those gamified areas of the application. The first we focused on was the leader board, which as seen previously, students struggled to access and view data on the leader board. This greatly affected our overall study goals as we were hoping to get students feedback about if the leader board made them more or less motivated when it came to taking quizzes. Secondly we focused on the self and peer assessment areas of MILAGE LEARN+ which seems to have positive reviews from students using the application. We did not however utilize the tutorial videos, question difficulty, or free response answer input types. Utilizing these additional aspects of the application could have affected our results.

Secondly, there are some limitations when it comes to our results focusing on students grades. One issue we ran into was MILAGE LEARN+ changing students answers, particularly on true false questions. There were enough students requesting grade changes for three of these questions, so they got an automatic 100% because of the glitch. This shouldn't have played too much of a role in our results as a majority of these

students did in fact get those questions correct, but the application switched their correct answers to the incorrect answers. Additionally there are limitations with the data we compared MILAGE LEARN+ student's scores to.

The Canvas data shown in figures 1 and 2, where from a previous semester's final exam, that contained the same questions and the one provided in the quizzes. Due to the fact that this final was a previous semester's exam, the group of students taking the Canvas questions and the group participating in the MILAGE LEARN+ quizzes, are two very different groups of students. Additionally, this final was a comprehensive exam that had a 2 hour time limit, compared to the ten quizzes that had no time limits attached. Also, because this was a final exam, these questions were proctored meaning that students had little to no ability to cheat. This is in comparison to the MILAGE LEARN+ quizzes that were un-proctored, so we are unaware of students cheating or not. Lastly, the questions received on the final had varying number of students respond to them, some as low as 17 students answering a particular question. Whereas MILAGE LEARN+ questions all had 37 or 38 submissions consistently.

The small number of participants was not a choice but a result of how many students were taking the course that semester and had access to a working MILAGE LEARN+ application. We recognize that students volunteering for this could be more motivated to participate, but there were also students who volunteered for it and ended up dropping out and moving back to Canvas because of issues with the MILAGE LEARN+ application. A total of 46 students used Canvas instead of MILAGE LEARN+.

Prior performance of students is unknown, but ultimately MILAGE LEARN+ is said to increase all students' performance [2, 4], which is why we decided on using averages and percentages for grades and correct answers, instead of highs and lows of individual's scores.

Finally, there were a few students in the course that were unable to participate in the MILAGE LEARN+ quizzes because the application is not very conducive to accessibility features. These students chose to opt out after viewing the application and determining that their software would not work with the MILAGE LEARN+ application. This limited the students in the classroom that were able to participate, and could have led to potentially different results.

VI. CONCLUSION

MILAGE LEARN+ is a mobile education application that is meant to boost students motivation and grades all through the different gamification pedagogies integrated in the application. MILAGE LEARN+ allows students to be flexible with their learning, continuing it outside of class wherever and whenever they please on their mobile devices. MILAGE LEARN+ incorporates self and peer assessment pedagogies in order to boost students autonomy and to help them see more than one correct way of answering a question. We set up MILAGE LEARN+ in a 400 level computer science course at a Research 1, land-grant university, and viewed students grades and feelings after taking 10 quizzes on the application. Students did not enjoy the application as much as we thought they might, but their

grades did improve compared to the students who took traditional Canvas quizzes. Overall there were limitations to our study and things to continue working on in the future, but MILAGE LEARN+ proved to have a positive impact on the grades of this particular study population and our results are similar to those encountered by [3].

A. Future Work

While there are issues within the application itself, that were solved meanwhile, there does need to be future work with our study itself. With the limitations we faced we believe that the next step would be integrating MILAGE LEARN+ into a similar classroom setting, but comparing grades between the two applications, within the same course. This would mean that participants opting into study would get to decide if they wanted to take the Canvas quizzes or the MILAGE LEARN+ quizzes. By doing this form of comparison, we can see exactly how comparable grades are between the two applications, within the same classroom. This would give us a better understanding of where the two applications line up with one another, and where they differ. In this same updated study, we would incorporate all of the gamification pedagogies available within MILAGE LEARN+. These could be seen with different difficulty levels for each quiz, tutorial videos, entering open response answers in different ways, and so much more. By doing this we also see the full capability of MILAGE LEARN+ in a 400-level computer science classroom.

Another possible future work would be to examine the impact of open answers questions with self and peer assessment to the quality of the learning process in computer science students, and compare these results with previous work done with organic chemistry students [3].

Finally, another topic to be researched in the future would be comparing students in a 400-level course to students in a 100-level course. This would allow us to see if MILAGE LEARN+ has a greater effect on either of the two groups, or if it provides the same benefits to every group. This would also need to be done the same semester, but with different courses. It would be interesting to see this done with a very introductory level course, and a potentially more difficult 400-level course. Is 100-level student's motivation affected more than those taking the 400-level course? Or are the two comparable enough to show that MILAGE LEARN+ is beneficial for all levels of university students.

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