Design and Assessment of Using Smartphone Application in the Classroom to Improve Students' Learning

https://doi.org/10.3991/ijep.v9i2.9764

Seifedine Kadry (✉), Bilal Ghazal
Beirut Arab University, Beirut, Lebanon
Lebanese University, Beirut, Lebanon
s.kadry@bau.edu.lb

Abstract—Teachers are always upset with students and their use of cell phones during classroom. Using of social media like texting, tweeting, and snap chatting during in class are an incredible disruption, resulting in a difficult education environment. In this article, we propose an innovative approach to encourage students to use their smartphone effectively in classroom and we evaluate our approach terms of students' performance and materials retention. The main idea behind this is to develop an easy and friendly application related to the course that may be accompanied by the used textbook. The proposed application can be adapted easily to any textbook or subject, where no prior knowledge of coding is required.

Keywords—Teaching; technology in classroom; higher education; mobile learning; dale's cone, blooms taxonomy, SAMR model.

1 Introduction

A recent study done in Toronto University showed that more than 95% of the university students possess smartphones [1]. However, many complains were done by teachers about the use of cellphones in classroom [1]. Texting, tweeting, posting blogs and snap chatting during class time are considered to be a major source of incredible distraction, making it difficult for educators to deliver and teach their prepared materials. It is pretty hard to compete with a very funny YouTube video as most people agree on. It is considered to be the most vexing issue of the digital age for teachers and administrators [1, 21]. Many debates where done regarding actions being taken with students' cell phones. Some agree on maintaining smartphones and other electronic devices in schools as a crucial competitive tool in a global market, while others insist that these devices distract students, compromising their learning time and focus [2]. In both cases, the problem using cellphones in class remains a major issue and is rapidly increasing, therefore educators must find a way to deal with this situation and need to find an appropriate solution for both parties [2, 3]. Hence, our research question is to evaluate the using of the proposed mobile application against students' performance and materials retention.

2 Literature Review

For the past decade or two, many mobile devices ranging from laptops, e-book readers, tablets and smartphones are considered to be important tools in the educational sector. Using both wireless communications and portable powerful devices, a new learning tool was developed promoting both vast effective information and innovation of education to the traditional classrooms [4, 5]. Mobile technology plays an essential role in creating new cooperative learning methods, self-exploratory learning outside the classroom and facilitating the development of communication, problem-solving and increasing academic performance among students [2, 3, 6].

A large number of educational institutions are now implementing the use of supplemental courses via smart devices and automated systems. This facilitates students in grasping more knowledge using their favorite electronic mobile device tool. Adapting many educational software by universities in their teaching programs, many software markets and mobile applications have increased rapidly supporting operating systems (OS) that are installed on mobile devices [7, 22]. Students are now capable of managing their study time by grasping updated e-books and online prerequisite materials using android, iOS and window mobile smartphones running on OS, making learning more flexible and time efficient [8]. Many advantages come with the use of mobile learning that can be summarized by the following points such as instant updates of course-related materials; reducing cost distribution and time marketing of old-version textbooks with instant updated online courses using Wi-Fi and cellular connectivity; flexibility in learning with no limitation to time or place; showing more interest in reading handy educational contexts versus occasional learning; time management and effectiveness during online quizzes and assessments [9].

Therefore, mobile technology using mobile applications have shown great potentials in facilitating and innovating educational methods, aiding educators to develop new ways of communications and advanced skill methods to effectively increase higher thinking levels for students in class and also off campus [10].

3 Methodology

In this study, we propose a textbook supplemental mobile learning application as a student resource that can be downloaded using a student's account. Math courses include many abstract topics in which many students usually struggle to understand them. The proposed application in math courses is capable of delivering the abstract topics in an active learning environment, making the course more dynamic and time productive for the users. Our research demonstrates an innovative learning approach by developing a simple mobile application designated to serve the specified course that is accompanied by a math textbook. This application encourages students in using their mobile phone in class with effective learning outcomes. Moreover, the proposed application has the ability to be implemented in many textbooks where the instructor does not need any coding requirements or IT special skills other than the easy MIT app inventor. It integrates math topics with mobile software platform that can be accessed by students registered in math course offered by the university. This application serves the students as a study guide tool during their studies by enhance their understanding various scientific concepts that can be illustrated using live images, videos and online quizzes, instant feedback during the lecture. Another aspect of this application is its ability to deliver instant updates about student evaluations and monitor their feedback [24]. It serves educators to frequently guide and motivates students by improving their performance.

Several studies focused on integrating mobile devices using applications of various types with teaching and education at universities to assist constructive learning by educators [11]. In this study, we will be focusing on how knowledge and informative education can be controlled and delivered by educators using mobile applications as a sort of reinforcement tool that help in motivating, strengthening classroom engagement and assisting constructive learning.

4 Application

This paper proposes a supplemental mobile application for mathematics based students, capable of delivering the fundamental and essential mathematics concepts. It integrates basic knowledge with mobile software platform that can be accessed by students registered for specified math course offered by the university. This application serves the students (users) as a study guide tool during their studies by understanding various scientific concepts that can be illustrated using live images, equations, formulas, videos and online quizzes. Recent studies have shown that mobile learning applications have highlighted important insights on the students' ability to enhance their learning to various stages and attempt many online tutorials and quizzes for self-assessments. Another aspect of this application is its ability to deliver instant updates about student evaluations and monitor their feedback. It serves educators to frequently guide and motivates students by improving their performance. Any new teaching methodology needs to be categorized by using Dale cone and Bloom's digital taxonomy frameworks since both of these frameworks have demonstrated effective teaching and learning outcomes over the past years. Both frameworks have shown classification of learning methods and corresponding retention rates via Dale cone framework and categorization of thinking skills via Bloom's digital taxonomy. In addition to these frameworks, another model is introduced in the online educational field known as SAMR, transforming learning experiences designed by educators to have a significant impact on students' outcome. Using both Bloom's digital taxonomy framework as well as SAMR model, cognitive skills are better targeted and aids in moving from traditional teaching tasks to student-centered mobile technology-integrated learning.

In conclusion, designing online assessments, tasks using mobile technology is indeed considered to be a key challenge for the instructor, encouraging more frequent use of learning technology as opposed to traditional teaching.

5 Case Study

A textbook supplemental mobile learning application can be downloaded using a student account offered by the university's website. This application focuses on supplementing additional online formative assessments including basic mathematical concepts, figures and online questions and student feedback. These features are accessed using a mobile smart phone device with Wi - Fi or cellular connectivity by logging into a student account. The courses designed in this application focuses on delivering basic mathematical concepts. The knowledge is gained deductively since this type of field lacks experimental learning models and therefore grasping the information is poorly established. Due to the continuous student demands for problem solving and tutorial sessions to assists them in the studying process, this application uses online quizzes helping the users to self-assess their knowledge and receive instant feedback throughout the course, enabling more efficient in-class interactions with flexibility in learning. The application therefore has the ability to enhance prerequisite materials and enable more efficient in - class interactions with flexibility in learning. Our application using MIT (Massachusetts Institute of Technology) App Inventor 2 version 2.39 (figure 1). The mobile educational application platforms are shown in figures 2 to 10.

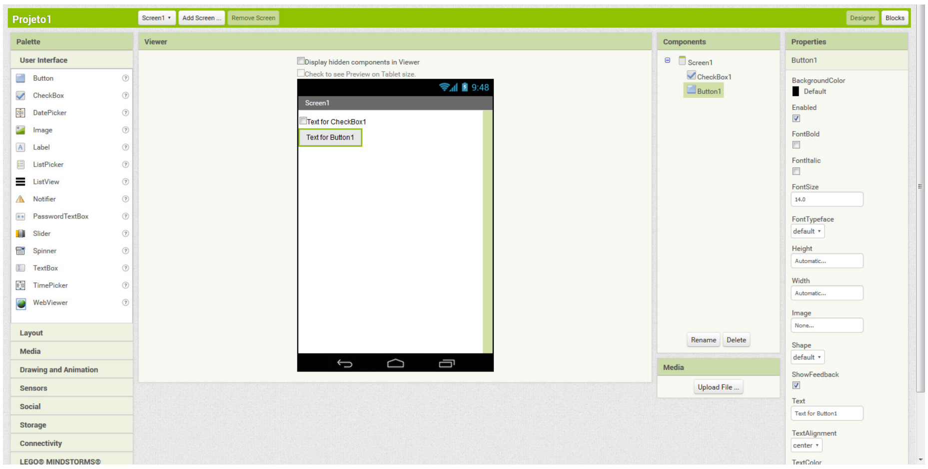


Fig. 1. The main interface of the App Inventor 2

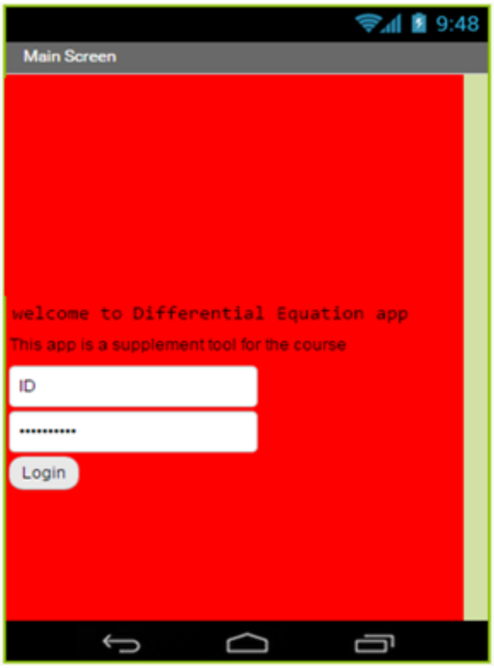


Fig. 2. Main screen of our application

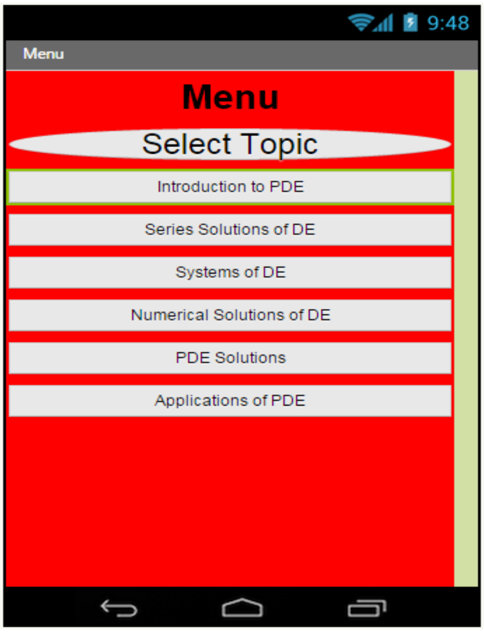


Fig. 3. Menu screen after adding the main menu

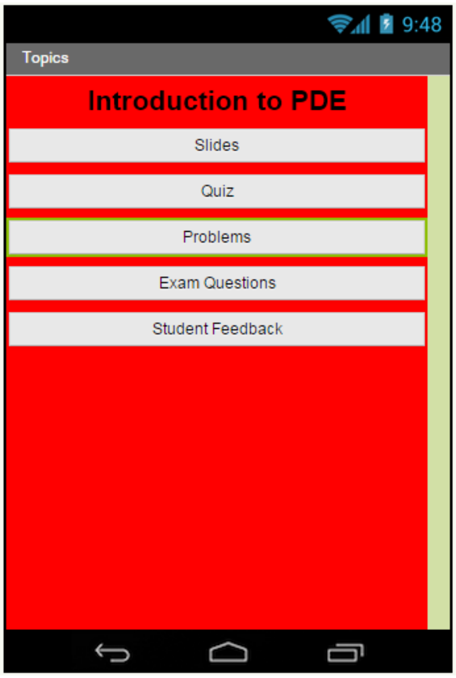


Fig. 4. Topics screen of the application after we select the first option

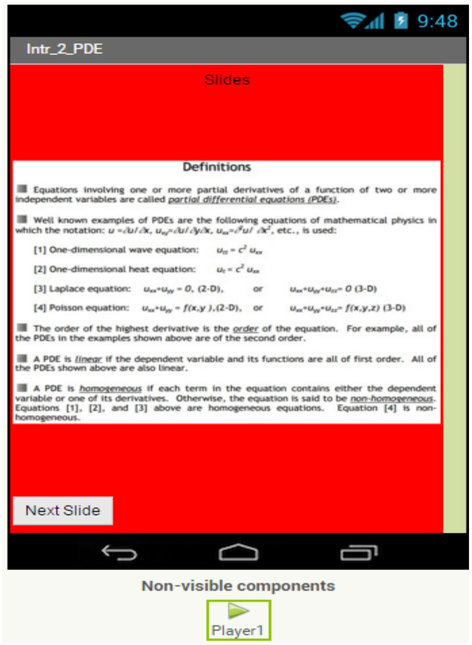


Fig. 5. Slides option

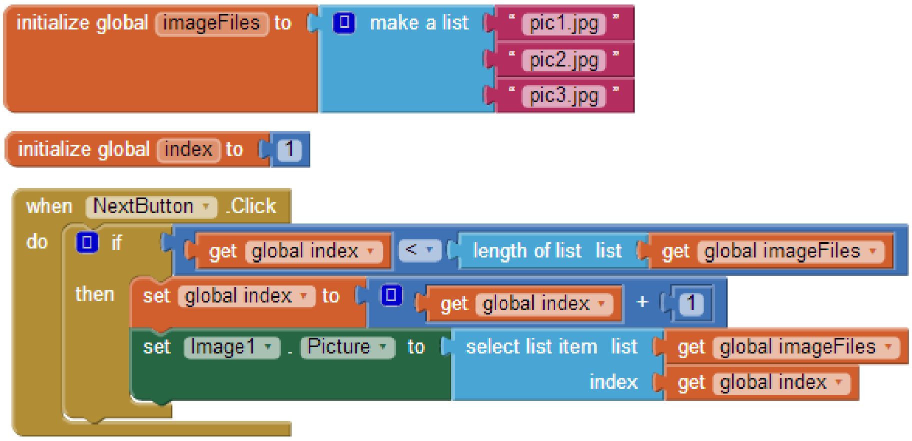


Fig. 6. Blocks screen of the Slides

5.1 Radio button

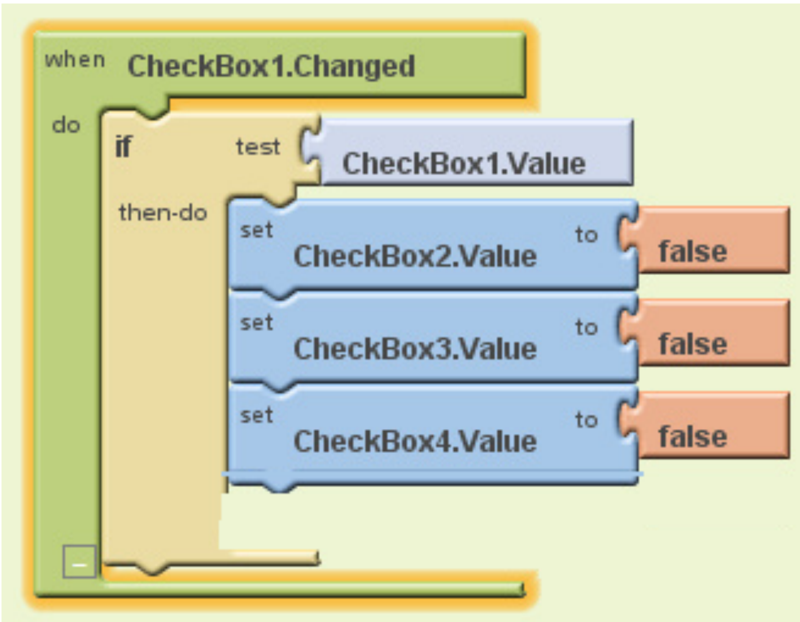


Fig. 7. Blocks screen of the radio button

5.2 Make quiz

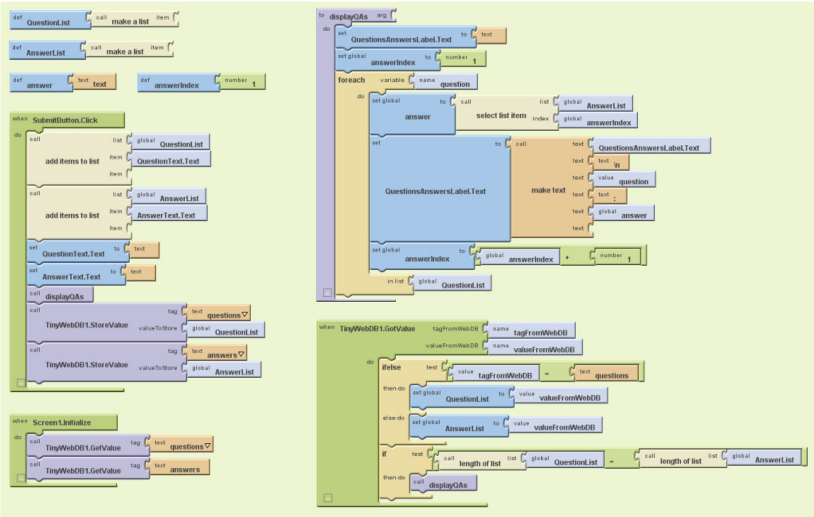


Fig. 8. Blocks screen of the making the quiz

5.3 Take quiz

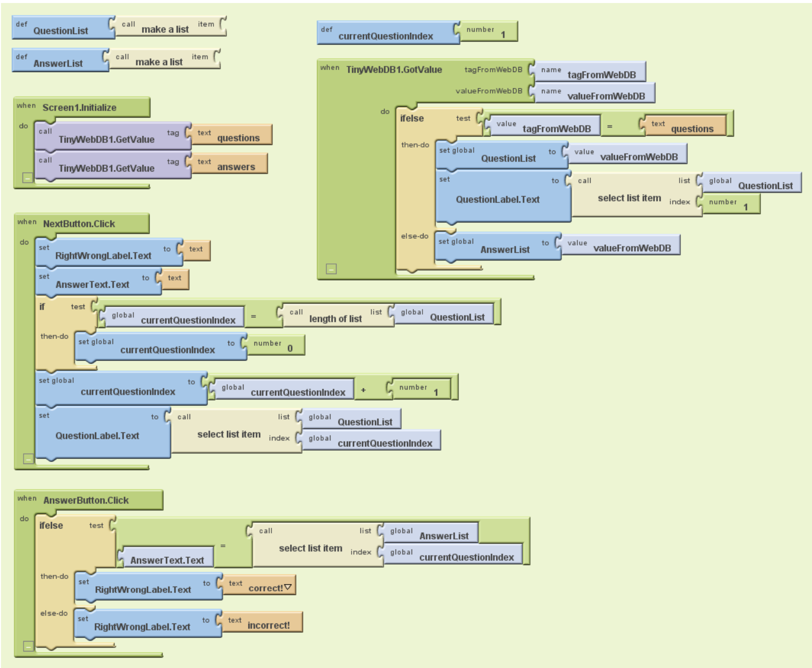


Fig. 9. Blocks screen of taking quiz

5.4 Student feedback

Fig. 10. Blocks screen of the student feedback

6 Dale Cone and Bloom's Taxonomy and Samr Model

It is imperative to categorize or classify any new method against the two well-known educational frameworks: Dale cone and Bloom's taxonomy. These two frameworks have been presented for more than 50 years and yet, it is commonly accepted that their general findings are still valid; also today, they create foundations for effective teaching and learning, regardless significant development of technology and use of new teaching-learning methods [12, [13].

6.1 Dale's cone

Dale's cone (Figure 11) is a categorization of different types of learning methods and the corresponding retention rates of information learned. The classification or cone of experience was developed by Edgar Dale, an American educationalist, in 1957 [3, 14].

According to Dale's theory, students can retain more information based on what they do as opposed to what they hear or read. This tool helps instructors in making decisions about resources and activities. Educational institutions have recently adopted a new teaching action plan "learning by doing" based the Bloom's taxonomy of experiences as seen in figure 12 [12].

Using verbal symbols such as listening to lectures in class, the least effective method at the top of the cone is targeted, delivering scientific information to students. The most effective and direct methods are those presented at the bottom of the cone [14]. These methods involve direct learning experiences, model simulators of real lessons and are considered to be closer to reality for students lacking the basic backgrounds. By targeting the lower portion of the chart, the higher the learning experience is retained in a large math courses.

We also suggest that the proposed application is considered to be a feasible and vital asset across scientific disciplines in order to re-design higher teaching and educational methodologies. Using the Dale's cone experience, instructors should be aware of the student's educational experience and were would it fit on the cone. Moreover, the instructor should be aware of the type of learning experience that needs to be provided in classrooms with the use of technology.

Using both the Dale's cone tool and the self-teaching/explanatory mobile application help students in strengthening their knowledge retention and reveals vital action-learning" techniques that might exceed 70% retention (further studies need to be accompanied in our future research paper).

According to our latest class observations, students' learning significantly increases using perceptual learning. Better interpreting and learning are achieved when using a real life updated application that relies on visual concepts rather than traditional verbal methods [14].

Therefore, designing instructional assessments related to advanced mathematical concepts using applications based on images, figures and videos build help in a much better understanding and more retention.

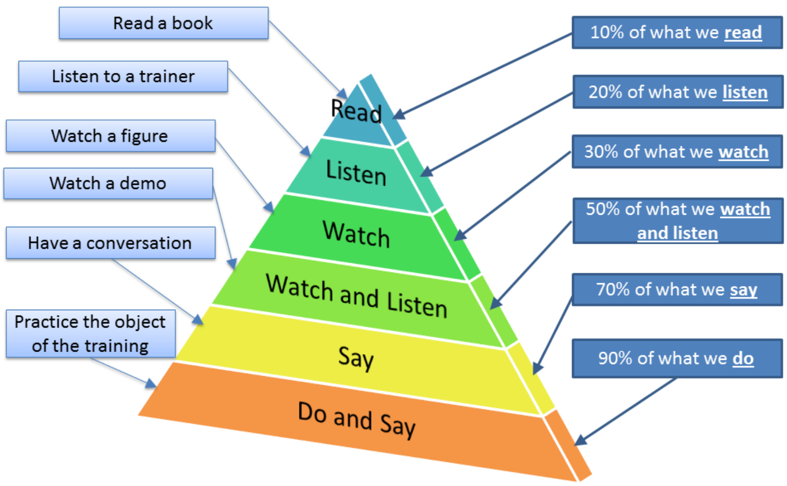


Fig. 11. Dale's cone

6.2 Bloom's taxonomy

Figure 12 shows Bloom's taxonomy classification of thinking skills. Bloom's taxonomy was created in 1956 by the leadership of educational psychologist Dr. Benjamin Bloom [15]. This taxonomy promotes higher forms of thinking in education such as analyzing rather than just remembering. The taxonomy was revised by Bloom's student in 2001 [16].

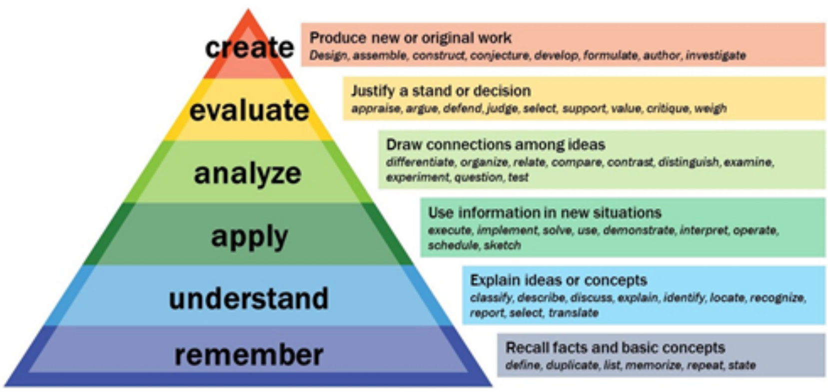


Fig. 12. Bloom's taxonomy

Table 1 provides a list of scientific terminologies used in mathematics that helps in facilitating the classification of the faculty's assessment in a taxonomy level. Each level in taxonomy describes different leaning outcomes.

Bloom taxonomy tool shows the ability to implement knowledge in a variety of educational settings and the need of complementary materials required by students to grasp. This tool is considered to be a useful guide for faculty members, helping students develop critical thinking skills and creating more challenging levels to expand their mathematical and scientific knowledge by using advanced questionnaire banks online assessment tutorials. Knowing the wide range of learning disciplines offered by Bloom taxonomy in many educational departments, this tool is used as a rubric in any scientific course to evaluate student's performance and achievements [17]. Moreover, this rubric is capable of developing formative assessment deliverables and aiding in course design [18] [19]. With the help of the Bloom taxonomy tool, faculty members and educators have the ability to better align their online assessments with their teaching activities, helping students to enhance their study skills and implement their mathematical concepts during their post-secondary studies. These tools serves as a modern comprehensive method for undergraduate faculties that can be easily used to guide and asses student learning, enhance teaching strategies and expand students' knowledge with updated live feeds, promoting learning online activities in mathematics.

Table 1. A list of measurable verbs used in mathematics

	New Terms	*Actions*	*Learning Activities*
Higher-order thinking	**Creating** (Putting together ideas or elements to develop an original idea or engage in creative thinking).	Designing Constructing Planning Producing Inventing Devising Making	***Creating:*** (Generating new ideas, products, or ways of viewing things) *How could we determine the number of pennies in a jar without counting them? Apply and integrate several different strategies to solve a mathematical problem. Design a new monetary system or an experiment for establishing …* Designing, constructing, planning, producing, inventing. *Invent a machine to do a specific task. Develop a menu for a new healthy foods restaurant.*
	Evaluating (Judging the value of ideas, materials and methods by developing and applying standards and criteria).	Checking Hypothesizing Critiquing Experimenting Judging Testing Detecting Monitoring	***Evaluating:*** (Judging the value of a product for a given purpose, using definite criteria) *Develop a proof … and justify each step …, Using a definition … determine …* Justifying a decision or course of action, checking, hypothesizing, critiquing, experimenting, judging *What criteria would you use to evaluate if your answer is correct? Prepare a list of criteria to judge… Evaluate expressions.*
	Analyzing (Breaking information into its component elements to explore relationships).	Comparing Organizing Deconstructing Attributing Outlining Structuring Integrating	***Analyzing:*** (Breaking information into parts to explore understandings and relationships) *Given a math word problem, determine the strategies that would be necessary to solve it. Write a paragraph describing the relationship …, How does … compare to …* Comparing, organizing, deconstructing, interrogating, finding *Design a survey to find out … Graph your results. Use a Venn Diagram to show how two topics are the same and different. Translate between visual representations, sentences, and symbolic notation. Make predictions based on experimental or statistical data.*
Lower-order thinking	**Applying** (Using strategies, concepts, principles and theories in new situations).	Implementing Carrying out Using Executing	***Applying:*** (Using information in concrete situations) *Compute the area of actual circles. Use the given graph to …, Choose and describe the best method to …* Using information in another familiar situation, implementing, carrying out, using, executing *Draw a diagram which shows these fractions or take photographs of the fractions. Determine measures of central tendency and dispersion Write a journal entry. Write an explanation about this topic for others.*
	Understanding (Understanding of given information).	Interpreting Exemplifying Summarizing Inferring Paraphrasing Classifying Comparing Explaining	***Understanding:*** (Grasping the meaning of material) *Given the mathematical formula for the area of a circle, paraphrase it using your own words. Select the graph that illustrates* Explaining ideas or concepts Interpreting, summarizing, paraphrasing, classifying, explaining *Find items that you can use to show the fractions. Retell or write in your own words… Report to the class… Write a summary report of the event.*
	Remembering (Recall or recognition of specific information).	Recognizing Listing Describing Identifying Retrieving Naming Locating Finding	***Remembering:*** (Remembering previously learned material) *State the formula for the area of a circle. State the rule of …, Explain and use the procedure for …* Recalling information, recognizing, listing, describing, retrieving, naming, finding, locating *List the fractions you know and can show. List the attributes of your shape. Make a concept map of the topic. Make a chart showing…*

6.3 SAMR model

The "Substitution Augmentation Modification Redefinition Model" known as "SAMR" is a new technological method that was introduced recently in the educational field. This framework was developed by Dr. Ruben Puentedura back in 2006 to help educators infuse technology into teaching and learning environment, and transforming learning opportunities as a result in higher academic achievements for students [20].

SAMR model serves in monitoring both progression of educational faculty members as they implement the use of technology in their teaching skills and how this technology impacts learning/teaching outcomes. Therefore, the goal behind these three models is to design and incorporate digital learning based on technology frameworks, resulting in a higher level of achievements for educators and students.

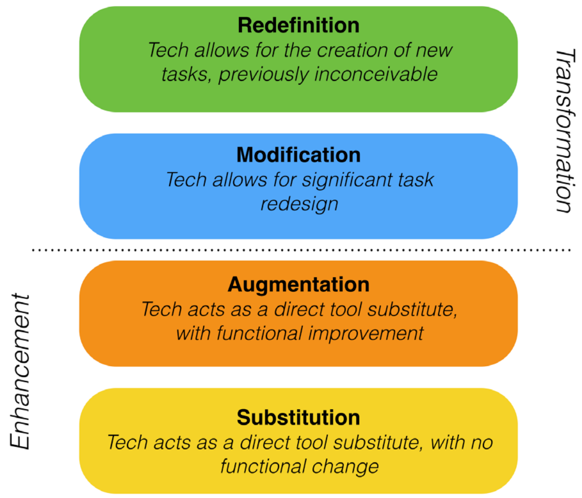


Fig. 13. Classification of both frameworks show classification of learning methods and corresponding retention

Any new teaching methodology needs to be categorized by using Dale cone and Bloom's digital taxonomy frameworks since both of these frameworks have demonstrated effective teaching and learning outcomes over the past years. Both frameworks have shown classification of learning methods and corresponding retention rates via Dale cone framework and categorization of thinking skills via Bloom's digital taxonomy (figure 13). The designed mobile application is inspired from SAMR model where our suggested teaching method falls in the "participation level" in the Dale's cone level and in the "Applying / Evaluating" in the Bloom's level (figure 14).

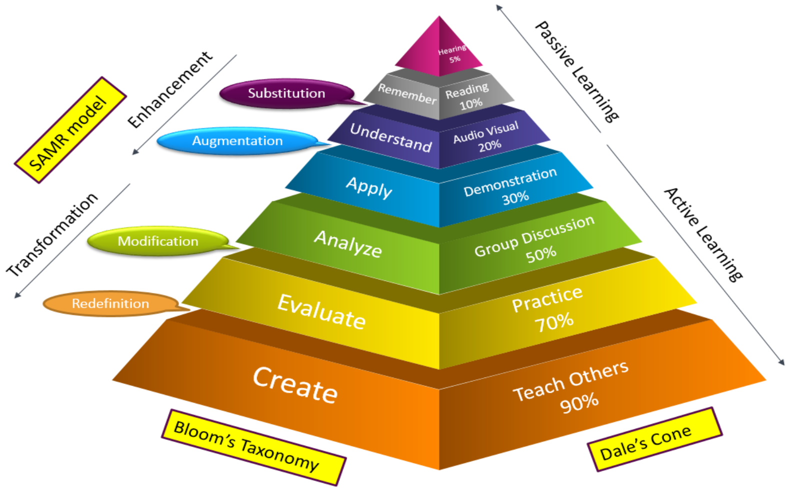
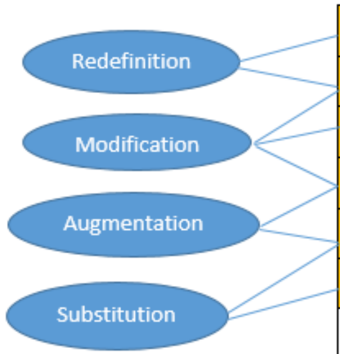


Fig. 14.SAMR model

Table 2 shows the situation of our new learning method with respect to: Bloom's Taxonomy, Dale's Cone of Experience, and SAMR model:

Table 2. Our method in Bloom's Taxonomy, Dale's Cone of Experience, and SAMR model.

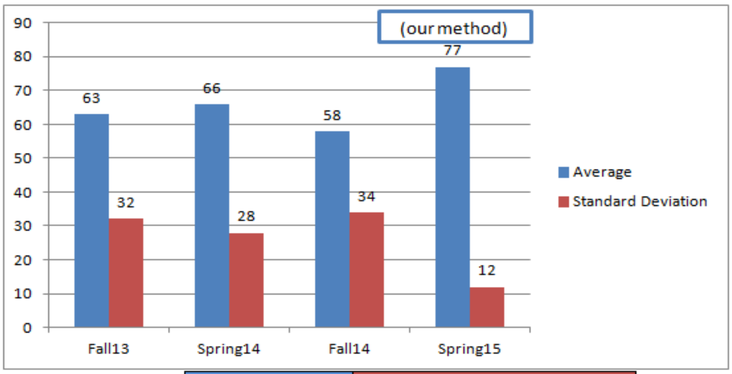


Bloom \ Dale	Reading	Hearing	Looking	Watching	Participating	Doing
Creating						
Evaluating					Our method	
Analyzing						
Applying					Our method	
Understanding						
Remembering						

7 Experimental Result

In this section, we will compare the result of an assessment in terms of average grades and variance with previous years and with the same year of other section that we taught using traditional teaching methodology. The course chosen in this study is a

Differential Equation for junior engineering students. The sample size is 30 students in each semester.



	Average	Standard Deviation
Fall13	63	32
Spring14	66	28
Fall14	58	34
Spring15	77	12

Fig. 15. Performance result comparison

As we can see from the previous figure, the result of our method is better than traditional way of lecturing. The average is higher and the standard deviation is the lowest, and basically this was our purpose to maximize the mean of grades and to minimize the standard deviation among students' knowledge.

The improvement of our method can be supported by studying the significant statistical test and the students' feedback from the small survey conducted at the end of the lecture.

As we notice the class average was improved but to say that with confident we need to statistically study the significant of our method through the T-Score test. For instance, the significant test between Spring2015 and Fall2014 is:

$$SE_{SP15} = \frac{sandard\ deviation}{total\ number\ of\ students} = \frac{12}{\sqrt{30}} = 2.19$$

$$SE_{FA14} = \frac{sandard\ deviation}{total\ number\ of\ students} = \frac{34}{\sqrt{30}} = 6.2$$

$$SE = \sqrt{2.19^2 + 6.2^2} = 6.57$$

$$t = \frac{77-58}{6.57} = 2.89$$

$$df = 29$$

The P-value is 0.00722 < 0.05. The result is significant.

7.1 Students' feedback and observation:

85% of the students found the method interesting, ass more fun and engagement, and ask to apply it again in other assessment.

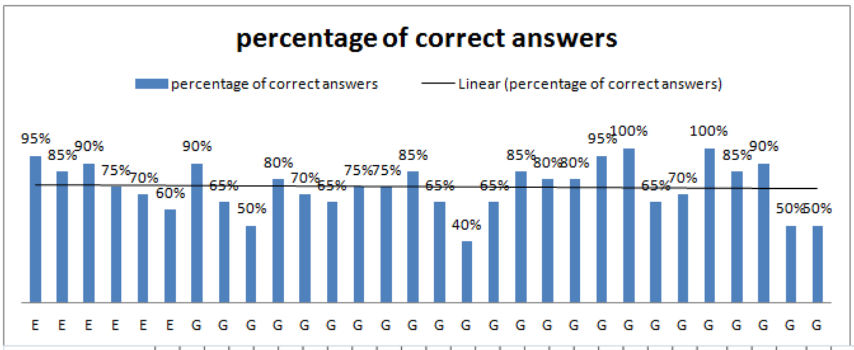
7.2 Students' learning retention analysis

In this section, we will examine the students' retention from learning perspective of our proposed method. The difference between learning and retention is summarized in the below table:

Table 3. Learning versus retention

Learning	Retention
Involves brain, nervous system, and environment Can learn something for a few minutes and then lost it.	Process by which long-term memory preserves learning so that it can locate, identify and retrieve it in the future.

To measure the retention of materials percentage, we conduct a pop quiz on the topics given in our experience after two weeks. We ask students to write down the steps that they remember to solve exact differential equation (same topics learned in our proposed method). The chart below shows the result (fig. 16):



stdudent#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
student type	E	E	E	E	E	E	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G
percentage of correct answers	95%	85%	90%	75%	70%	60%	90%	65%	50%	80%	70%	65%	75%	75%	85%	65%	40%	65%	85%	80%	80%	95%	100%	65%	70%	100%	85%	90%	50%	50%

Fig. 16. Retention measure

The average rate of material retention after two weeks of the activity of our proposed method is 75%. The same pop quiz conducted on my second class where the lecture-based method is used gave 55% of the student retention.

8 Conclusion

This proposed study shows a new supplemental teaching method that helps in supporting a mathematic textbook during an undergraduate program. Designing the application by an instructor does not rely on any technical skills or any prior programing knowledge. This paper shows the benefits of our teaching methodology which is illustrated by three well-documented education evaluation models: Bloom, Dale, and SAMR. More work and surveys will be performed inside and outside classes using this designed application for math and other undergraduate courses. Student's performance using our new teaching methodology application will also be examined and analyzed before and after the use of our designed supplemental application guide.

9 References

[1] Fukuzawa, S., and Boyd, C. (2016) "Student Engagement in a Large Classroom: Using Technology to Generate a Hybridized Problem-based Learning Experience in a Large First Year Undergraduate Class,"*The Canadian Journal for the Scholarship of Teaching and Learning*: Vol. 7: Iss. 1, Article 7. https://doi.org/10.5206/cjsotl-rcacea.2016.1.7

[2] Roschelle, J., Rafanan, K., Bhanot, R., Estrella, G., Penuel, B., Nussbaum, M., et al. (2010). Scaffolding group explanation and feedback with handheld technology: impact on students' mathematics learning. *Educational Technology Research and Development*, 58, 399e419. http://dx.doi.org/10.1007/ s11423-009-9142-9.

[3] Warschauer, M. (2007). A teacher's place in the digital divide. *Yearbook of the National Society for the Study of Education*, 106, 147e166. http://dx.doi.org/10.1111/j.1744-984.2007.00118.x.

[4] Fleischer, H. (2012). What is our current understanding of one-to-one computer projects: a systematic narrative research review. *Educational Research Review*, 7, 107-122. http://dx.doi.org/10.1016/j.edurev.2011.11.004.

[5] Zucker, A. A., and Light, D. (2009). Laptop programs for students. Science, 323, 82-85. http://dx.doi.org/10.1126/science.1167705.

[6] Lan, Y. J., Sung, Y. T., and Chang, K. E. (2007). A mobile-device-supported peer-assisted learning system for collaborative early EFL reading. *Language Learning & Technology*, 11, 130e151. Retrieved from http://llt.msu.edu/vol11num3/pdf/lansungchang.pdf.

[7] Hu, W., and Guo, H. "Curriculum architecture construction of mobile application development", in *Proc. 2012 International Symposium on Information Technology in Medicine and Education*, Japan, 2012, pp. 43-47.

[8] Cochrane, T. and Bateman, R., "Smartphones give you wings: pedagogical affordance of mobile Web 2.0," *Australasian Journal of Educational Technology*, vol. 26, no. 1: pp. 1-14, 2010. https://doi.org/10.14742/ajet.1098

[9] McAndrew, T. Approaches to e-Learning Development in Biosciences: A Report of Case-Study Visits Undertaken for the Distributed e-Learning Projects, 2008.

[10] Greenwood, L., McBride, F., Morrison, V., Cowan, P., and Lee, V. "Can the Same Results be Obtained Using Computer-mediated Tests as for Paper-based Testing," in *Proceedings of the International Conference in Mathematics/Science Education and Technology*, ed. P. Schwartz and g. Webb, San Diego, California, USA, 2000.

[11] Hwang, G. J., and Tsai, C. C. (2011). Research trends in mobile and ubiquitous learning: a review of publications in selected journals from 2001 to 2010. *British Journal of Educational Technology, 42, 65-70.* https://doi.org/10.1111/j.1467-8535.2011.01183.x
[12] Lalley, J. P., and Miller, R. H. (2007). The Learning Pyramid: Does It Point Teachers in the Right Direction?. *Education* 128, No. 1: 64-79.
[13] Dange, J. (2014). Learning and Experiences. *Lap Lambert academic Publications*. Germany.
[14] Edgar, D. (1969). Audio-visual methods in Teaching. (3rd ed).New York: *The Dryden Press*.
[15] Bloom, B. S., Krathwohl, D. R., and Masia, B. B. (1956). Taxonomy of Educational Objectives: The Classification of Educational Goals, New York, NY*: D. McKay*.
[16] Cohen, E., Brody, C. and Sapon-Shevin, M. 2004. Teaching cooperative learning. Albany, NY*: State University of New York Press*.
[17] Bissell, A. N., and Lemons, P. P. (2006). A new method for assessing critical thinking in the classroom. *BioScience 56*, 66–72. https://doi.org/10.1641/0006-3568(2006)056[0066:ANMFAC]2.0.CO;2
[18] Allen, D., and Tanner, K. (2002). Approaches to cell biology teaching: questions about questions. *Cell Biol*. Educ. *1*, 63–67. https://doi.org/10.1187/cbe.02-07-0021
[19] Allen, D., and Tanner, K. (2006). Rubrics: tools for making learning goals and evaluation criteria explicit for both teachers and learners. *CBE Life Sci. Educ*. *5*, 197–203. https://doi.org/10.1187/cbe.06-06-0168
[20] Georgios F., Paschalina K., Konstantinos K (2018) Designing Math Trails for Enhanced by Mobile Learning Realistic Mathematics Education in Primary Education. *iJEP – Vol. 8, No. 2.*
[21] Dimitris M., Georgios F. (2016). Rapid Prototyping of Interactive Storytelling and Mobile Augmented Reality Applications for Learning and Entertainment – The case of "k-Knights*". iJEP – Vol. 6, No. 2.*
[22] Tracy, K.W. "Mobile Application Development Experiences on Apple's iOS and Android OS", *IEEE Trans. IEEE Potentials*, vol. 31, pp. 30-34. August 2012. https://doi.org/10.1109/MPOT.2011.2182571
[23] http://www.thelocal.se/20161007/why-swedish-schools-are-using-social-media-to-lure-students)
[24] Athanasios D., Karyotaki M. (2014) Learning Tools and Applications for Cognitive Improvement. *iJEP – Vol. 4, No. 3*

10 Authors

Seifedine Kadry is an associate professor of computing in the department of mathematics and computer science, Faculty of Science at Beirut Arab University, Beirut, Lebanon.

Bilal Ghazal is an associate professor of computer science at the faculty of sciences section IV in the Lebanese University, Zahle, Lebanon.

This article is a revised version of a paper presented at the EDUCON2018 conference held in Santa Cruz de Tenerife, Spain, 17-20 April 2018. Article submitted 2018-10-27. Resubmitted 2019-01-20. Final acceptance 2019-01-21. Final version published as submitted by the authors.