

Integrative Application of an Educational Wiki and Flipped Classrooms: Student Learning Outcomes and Impacts on Doing Academic Group-Works

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Abstract

Background: Active participation in group works is an invaluable way to realize collaborative learning; however, there are several challenges attributed to the traditional way of doing group works. This study explores the synergistic effects of flipped classrooms and a wiki-authoring group activity on students' learning outcomes and the quality and quantity of their group-work.

Methods: In this action research, 205 master students of a medical school were involved in a course blended with flipped classrooms. While learning from online and in-class activities, students did their group work on an educational wiki or in a conventional way. Using SPSS 21.0 and employing independent samples t or Mann –Whitney U tests, the educational impacts of the course were compared in two groups.

Results: Students in the wiki-group were more satisfied with the course. Both quantity and quality of the group work among students in the wiki group was outweighed those among the students in the non-wiki group. Univariate linear regression analysis of the models between students' satisfaction with flipped classrooms and the quality of their participation in doing their group as well as their attitude towards the group work showed that the changes in the quality of the wiki students' group work and their attitude were dependent on the changes of their satisfaction with flipped classrooms.

Conclusions: This study provides evidence that a wiki-authoring group work is effective in achieving student learning outcomes and integrating a wiki with flipped classrooms increases wiki accomplishment. Collaborating on a wiki activity improves both quality and quantity of group works among students.

Background

Students' collaborative and individual learning are positively related to each other(1). Active participation in group works is an invaluable way to realize collaborative learning(2); however, there are several challenges attributed to the traditional way of doing group works (3). Traditionally, teachers have a poor supervision over students' activities during the course. During the course, no feedback on their work is provided by the course teacher. Usually, just one or two students complete the group work on behalf of all group members. Teachers usually assess students' works just at the end of the course. Because of that poor supervision and late assessment, the exact quantity and quality of participation of each student in the group work is not specified and the same scores are given to all students in the group.

In order to decrease the challenges attributed to the traditional way of doing group works and to respect millennials' appreciation for technology(4),the opportunities for collaborative learning are provided through educational wikis are in some of the leading universities in the United Kingdom, America, Canada, Switzerland, New Zealand and Germany(5). Wiki is a platform composed of one or more web pages connected to each other. People can write on and store information freely on it. They can also edit their own or others' content on a wiki. Engaging in a wiki activity, students transfer their learning into a

common work. While learning independently in accordance with their own learning style, they learn from the peers as well(6). So, a wiki can facilitate group collaboration, knowledge acquisition and writing skills of participating students(7).

Although recently, wikis are extensively adopted in education and their worth in collaborative learning is confirmed, it was concluded in an integrative review that wikis' effectiveness in "achieving student learning outcomes" is uncertain and further effectiveness assessment studies are needed. Moreover, based on the findings of another study at the Victoria University of Wellington, wiki alone is not enough to enhance the attitude of the students towards their group work(8). Because of the informal nature of a wiki activity, students may share imprecise and less-academic information on it. In order to increase the effectiveness and quality of the group activity on a wiki, it is recommended that facilitation of critical judgment should be considered in the design of the group works and students should be familiar with how to access the necessary sources(8). Integrative application of wikis; electronic contents (podcasts); web log activities such as discussions on a forum and student-tutor interactions is recommended by some research(9). According to that research, synergistic contributions of the above- mentioned elements may enhance students' learning and may provide "a coherent wholesome learning experience" for them(9).

Considering the suggestions to investigate the learning values of wikis combined with other educational interactions, some questions raise in mind: Is a wiki-authoring group work effective in achieving student learning outcomes? Does a wiki-authoring group work enhance students' attitude towards their group work? Does integrating a wiki with flipped classrooms increase wiki accomplishment?

To answer these questions, this action research intends to explore the synergistic effects of a wiki-authoring activity integrated with flipped classrooms on 205 master students' learning outcomes and the quality and quantity of their group-work. It is hypothesized that holding FCs will promote students' attitude towards their wiki-supported group work and will increase the both quality and quantity of their group work as well.

Methods

Research design and setting

This action research was conducted to explore the impacts of a course blended with flipped classrooms on both the attitude of master students towards their wiki-supported group work and the quality of their group work. It was took place at the education development center affiliated with our university of medical sciences in six consecutive semesters, from September 2016 to December 2019. Conducting the study was approved by the university ethics review board (N: 1396.1129).

Participants

Participants were master students at the School of Medicine. All students had to pass a course entitled: "Writing and presenting articles in English", in the first two semesters of their study at medical school. During four semesters, 205 master students enrolled in this course. They were studying in eight different disciplines: physiology, biochemistry, bacteriology, virology, anatomy, immunology, hematology and medical education. All students, who had not previously passed a similar course, were included in the study. Later, the data about the students who had not completed the research questionnaire was set aside and only the data on 171 remaining students was analyzed.

Intervention

All students were involved in a blended course, with both online and in-class parts. While learning from online and in-class activities, students were asked to do a group work. They were free to choose one of the two available options for doing their group assignment. Those options were doing the group work through an educational wiki or doing it in a traditional way. Regardless of their selected option, all students were informed that 40 percent of their overall score would be allocated to their group work. Students in both groups had to follow all in-class and out-of-class activities. The only difference between the two groups was in the form of their group work, so the results of the study will be classified into two groups: wiki or non-wiki groups. .

Out of class activities of the course

This part was delivered through an open-source and freely available Moodle (Modular Object-Oriented Dynamic Learning Environment)(10). The version of employed Moodle was 3.0.4. (11). An orientation session was hold to ensure that all students can manage all predetermined activities on the platform.

Using the iSpring Suite 8 software, twelve electronic- content (e-content), in the form of the sound synchronized with PowerPoint slides, were produced and uploaded into the platform. Those contents were standard in format and the students could control them on their own players (on a personal computer or a smartphone). The e-contents covered all the learning objectives of the course and students could use them many times, in their desired time and place.

The expected online activities were: studying e-contents of the course and discussion on a forum. Students in the wiki group had to do their group work on line, as well.

In-class activities of the course

In this part, students attended flipped classrooms (FCs). Students were divided into groups of four. They were asked to summarize the content of each session in their group and bring a one-page summary to the class. They were also requested to be prepared for a 15-minute in-class presentation. They were

explained that each session they should take on different roles (presenter, note taker or writer) in the group.

Details for students activities in each FC, divided by in or out of class activities, according to their implementation order are summarized in Table 1.

Table 1

Details for students activities during a semester, divided by in or out of class activities, according to their implementation order

	Order	Type of activity	Description	Duration
Online(out-of class) activities	1	Self-regulated learning	Downloading and listening to the e-contents, whenever and wherever students liked (flexible asynchronous e-learning)	Variable according to students' interest and need
	2	Group discussion in a forum	Raising questions in the forum and discussion with each other(peer-assisted learning)	
in-class activities(at flipped classrooms)	3	Quiz at the beginning of the class	Discovering any possible misunderstandings of the content(formative assessment)	10 minutes
	4	Summary sharing by students	Sharing a brief one-page summary of the e-content of that session with other groups(collaborative learning)	10 minutes
	5	Student presentations	A 15-minute presentation by one group (Peer education)	15-minutes
	6	QA & Group discussion	Questions and answers from students and facilitation by the teacher	35 minutes
	7	Micro lecture by the teacher	Summarizing and closing the session	10 minutes
	8	Quiz at the end of the class	Summative evaluation	10 minutes

Wiki activity

The version of the wiki, which was used in this research, was 2015111600 (11)(Dent et al., 2017)(Dent et al., 2017)(Dent et al., 2017) (Delandshere & Arens, 2003)and its programming language was PHP (Hypertext Preprocessor)(12). It had been already installed with the Moodle package and had a simple markup formatting. Students in the non-wiki group, who did their group work in the traditional way, did not have access to the wiki on the LMS (Learning Management System).

The wiki had various features including, writing and editing text, importing and editing images, importing audio and video files, drawing tools, drawing and editing tables, hyperlinking, inserting and editing statistical formulas, structuring and organization of the text.

Through a pilot study, wiki's features were improved based on the feedback from eight peer students and five peer researchers. Reflections by the research team were helpful as well. After the modifications, the features of search, spell check, insertion of emotions and email notification were added to the wiki too.

The learners' group work was focused on a collaborative writing about do's and don'ts in writing the articles in English. Applying the above mentioned features of the wiki, students were able to start writing, editing and structuring from everywhere in the text. They could also structure their group writing with the subject division hierarchical method. Each semester, the wiki was available for only students of that term. So, students could contribute to the web pages of their own group.

The course teacher (SGH) was able to supervise LMS activities of all learners 24 hours a day. By controlling history and logs of the learners, she was able to assess both the quantity and the quality of each student's activity on the LMS and wiki. So it was possible to differentiate the various activities of the students in the system. Different activities of students included a simple log in, moving between pages or typing and editing in the wiki. When students made any changes in their writing, those changes would be highlighted in the text. Those highlights were evaluated by the teacher. When the quantity or quality of a student's activity was not desirable, the teacher sent an email to her/him via the LMS. Drawing figures of "content access", "number of active participants" and "hits distribution", the teacher realized passive or very active students. Those figures also helped the teacher figure out which contents were not accessed by every student.

Evaluation of the intervention and data analysis

First, students self-assessed their satisfaction with different educational activities of the course. They also specified the amount of their learning from each component of the course. An 11-item satisfaction questionnaire was designed and validated for the present study. To assess the content and face validity of the satisfaction questionnaire, ten experts in the field of medical education evaluated the necessity, relevance, appropriateness and clarity of the items (13, 14) and 6 master students examined any ambiguity in understanding of the items(13, 14). Internal consistency of the items was assessed by calculating Cronbach's Alpha and Intra-class Correlation Coefficient (ICC) was calculated to judge the stability of the results (14). For doing so, 30 master students completed the questionnaires twice with a two-week interval.

Students' satisfaction with each item of the questionnaire was specified, employing a five-point Likert scale (Very high, above average, Average, below average, Very low). Students specified their attitude toward performing their group, responding to 5 questions with the same Likert scale.

Students' learning was assessed in two ways: First, as a formative assessment, both the quantity and the quality of each student's participation in doing their group work were continually evaluated during the semester. At the end of the semester, the quantity and quality of each student's participation was rated in a range from zero to five, using a five-item checklist. Second, students' average score in their summative exam was used to assess their learning. The summative exam included extended matching items, multiple choice questions and fill-in-the-blanks items.

Students' competency in transferring their learning into creating an outline for a hypothetical article and writing topic sentences for each part of that article was used to assess the impact of the course. That competency was examined in students' summative exam.

In order to regard some unanticipated consequences of the wiki-authoring activity, all learners were asked to critique the process of their co-construction activity as well. Students' feedback together with their aliases was emailed to the course teacher by the class representative immediately after the end of the semester.

Statistical analysis

Students' satisfaction with each component of the education; their overall self-declared satisfaction with the whole course; their average score in the summative exam of the course; quantity and the quality of each student's participation in doing their group work and also their attitude toward performing their group were described in wiki and non-wiki groups, reporting proper descriptive statistics.

Employing independent samples t test or Mann –Whitney U test, the results of the course were compared in two groups. As the distribution of some variables was not normal, they were first transformed to their natural logs. Then, the correlation between the mean score of students' satisfaction with flipped class rooms and the mean score of the quality of each student's participation in doing their group work as well as their the mean score of their attitude towards their group work were investigated, using Spearman's rank correlation coefficient. The causal associations between those variables were evaluated by univariate linear regression analysis. The data was analyzed Using SPSS for windows version 21.0. Significant meaningful differences were reported based on the Asymp.Sig. (2-tailed). Values of P less than 0.05 were considered statistically significant.

Results

During six academic semesters, 205 master students of medical sciences took part in this action research and 85 of them voluntarily chose to have wiki activities. In all, 70 out of 85 students in the wiki group and 101 out of 120 in the non-wiki group completed the satisfaction questionnaires (response rates: 82.4%, 84.2%, respectively). Later, only the data about 171 respondents were analyzed.

The mean age of students in the wiki and non-wiki groups were 24 ± 2 and 25 ± 3 years, respectively. Women accounted for 75% in the wiki and 65% in the non-wiki groups.

The satisfaction questionnaire was validated by the active participation of 10 experts and 6 master students. Content Validity Ratio (CVR) and Content Validity Index (CVI) of the questionnaire were 0.71 and 0.87, respectively. The satisfaction questionnaire demonstrated an Impact Score = 3.81, Cronbach's α = 0.83 and ICC = 0.724 ($p < 0.00$).

Students' satisfaction with each component of the education in both groups is presented in Table 2. Based on the self-assessment results, the mean score of the students' overall satisfaction in the wiki group was 40.30 ± 3.70 ; while it was 37.23 ± 3.00 in the non-wiki group (P-value = 0.000).

Table 2

Description* of students'** satisfaction with each component of the education in a course blended with flipped classrooms, divided by their collaboration way in doing their group work

Component of education	Satisfaction item	Wiki-group(n = 70)	Non-wiki group(n = 101)
E-content s	Fitness of the content of e-content to my needs	3.60 ± 0.88	3.70 ± 0.93
	The quality of e-content	3.76 ± 0.82	3.71 ± 0.92
Forum	The usefulness of forum discussions	2.60 ± 0.65	2.67 ± 0.63
	User-friendliness of the forum discussions	2.76 ± 0.75	2.56 ± 0.71
Flipped classroom	The effectiveness of the in- class discussions	3.36 ± 0.68	3.33 ± 0.69
	Possibility to participate in class discussions	4.17 ± 0.64	3.96 ± 0.58
	The worth of summary sharing in learning	4.07 ± 0.62	4.04 ± 0.49
	The value of student presentations in learning	4.03 ± 0.54	4.02 ± 0.55
	The role of teachers' brief lecture	4.20 ± 0.73	4.00 ± 0.85
Group work	Appropriateness of the group work	3.96 ± 0.84	2.65 ± 0.71
	The helpfulness of the group work	3.80 ± 0.81	2.57 ± 0.78
Attitude towards the group work	The value of group work in motivating me to learn more	3.81 ± 0.84	2.62 ± 0.72
	The impact of the group work to increase my confidence in writing an article	3.69 ± 0.97	2.56 ± 0.62
	The worth of the group work in identifying my weaknesses and strengths in writing articles	3.66 ± 0.92	2.53 ± 0.67
	The importance of the group work experience in building my teamwork skills	3.64 ± 0.82	2.69 ± 0.64

*All numbers describe Mean ± SD of satisfaction with each item

**Master students in medical school, who did their group work during a semester based on a wiki or face-to- fact collaboration

Component of education	Satisfaction item	Wiki-group(n = 70)	Non-wiki group(n = 101)
	The role of the group work in encouraging me to participate in similar experiences	3.81 ± 0.84	2.78 ± 0.72
The whole course[∞]	Satisfaction with the whole course (self-declared)	3.84 ± 0.81	3.38 ± 0.79
*All numbers describe Mean ± SD of satisfaction with each item			
**Master students in medical school, who did their group work during a semester based on a wiki or face-to- fact collaboration			

The effects of the course on the learning and satisfaction of the students in both groups are compared in Table 3.

Table 3

Comparison of the effects of a course, blended with flipped classrooms, on the learning and satisfaction of the students* in wiki (n = 70) with non-wiki (n = 101) groups

Result measure	Group	Mean ± SD**	Normal Range of mean	Mean Rank	Significance
Number of e-contents, which were downloaded and studied by students	Wiki	10.90 ± 1.00	0 to 12	96.23	0.019
	Non-wiki	10.51 ± 1.08		78.91	
Score of the quiz at the beginning of the class	Wiki	3.36 ± 0.78	0 to 5	90.79	0.243
	Non-wiki	3.22 ± 0.72		82.68	
Score of the quiz at the end of the class	Wiki	4.09 ± 0.65	0 to 5	92.24	0.118
	Non-wiki	3.93 ± 0.62		81.67	
Score of the quantity of the participation in doing the group work	Wiki	3.54 ± 0.50	0 to 5	Π119.60	< 0.001 [∞]
	Non-wiki	2.67 ± 0.57		Π62.71	
Score of the quality of the participation in doing the group work	Wiki	4.11 ± 0.65	0 to 5	Π125.61	< 0.001 [∞]
	Non-wiki	2.86 ± 0.66		Π58.54	
Final exam score	Wiki	16.59 ± 1.04	0 to 20	Π124.76	< 0.001 [∞]
	Non-wiki	14.52 ± 1.38		Π59.13	
Score of competency in writing an outline and topic sentences for a hypothetical title	Wiki	16.51 ± 1.32	0 to 20	Π132.11	< 0.001 [∞]
* Master students in medical school, who did their group work during a semester based on a wiki or face-to- fact collaboration					
ΠVariables, which their distribution was not normal					
**About variables, which their distribution was not normal, Mean ± SDs are written just for the ease of the comparison					
α Significance of independent samples t test					
∞ Significance of Mann-Whitney U test					

Result measure	Group	Mean ± SD**	Normal Range of mean	Mean Rank	Significance
	Non-wiki	12.25 ± 2.35		Π54.04	
Score of satisfaction with uploaded e-contents	Wiki	7.36 ± 1.38	2 to 10	84.10	0.665
	Non-wiki	7.42 ± 1.50		87.32	
Score of satisfaction with forum activities	Wiki	5.36 ± 1.10	2 to 10	90.05	0.353
	Non-wiki	5.24 ± 1.04		83.19	
Score of satisfaction with flipped classrooms	Wiki	19.83 ± 1.58	5 to 25	95.76	0.028α
	Non-wiki	19.35 ± 1.49		79.23	
Score of satisfaction with group work	Wiki	7.76 ± 1.41	2 to 10	Π126.19	< 0. 001∞
	Non-wiki	5.23 ± 1.25		Π58.14	
Score of satisfaction with the whole course	Wiki	40.30 ± 3.70	11 to 55	Π114.88	< 0. 001∞
	Non-wiki	37.23 ± 3.00		Π65.99	
Score of the attitudes towards the worth of the group work	Wiki	18.61 ± 3.46	5 to 25	Π125.34	< 0. 001∞
	Non-wiki	13.20 ± 2.26		Π58.73	
* Master students in medical school, who did their group work during a semester based on a wiki or face-to- fact collaboration					
ΠVariables, which their distribution was not normal					
**About variables, which their distribution was not normal, Mean ± SDs are written just for the ease of the comparison					
α Significance of independent samples t test					
∞ Significance of Mann-Whitney U test					

In the wiki group, students performed their group work on a common wiki. The range for their completed work in each semester was 34 to 48 pages. Eighty seven percent of the students received feedback, on both the quantity and quality of their participation. The mean time of the constructive feedback provided by the teacher was three for each student. Students in non-wiki group submitted their group assignment to the course teacher at the end of the semester. Although all students were requested to ask for the teacher's feedback every time during the term, those in the non-wiki group never asked for her feedback. The range for the completed work in this group was 15 to 23 pages.

Neither students in the wiki, nor those in the non-wiki welcomed discussions in the forum. Eleven and eight questions and answers (Q&As) were presented in the forum in the wiki and non-wiki groups, respectively.

Students' satisfaction with flipped classrooms correlated at $r = 0.485$ (Sig = 0.017) with quality of their participation in doing their group work for 70 students in the wiki group. That Spearman's rho was -0.200 (Sig = 0.045) for 101 students in the non-wiki group.

The correlation of students' satisfaction with flipped classrooms with their attitude towards their group work was $r = 0.508$ (Sig = 0.000) and -0.234 (Sig = 0.019) in the wiki and non-wiki groups, respectively.

Table 4 represents the summary and parameter estimates of the models, in which students' students' quality of their participation in doing their group work and their attitude towards their group work are dependent on their satisfaction with flipped classrooms.

Table 4

Model Summary and Parameter Estimates of the Model between students'* satisfaction with flipped classrooms; quality of their participation in doing their group work and their attitude towards the group work

Model		Unstandardized Coefficients		Standardized Coefficients	t	P-Value
		B	Std. Error	Beta		
1 _a	(Constant)	0.35	0.29		1.17	0.24
	Satisfaction with flipped classrooms	0.63	0.23	0.20	2.77	0.006
2 _b	(Constant)	-0.20	0.34		-0.58	0.56
	Satisfaction with flipped classrooms	0.76	0.27	0.21	2.81	0.005
a. Dependent Variable: students' quality of their participation in doing their group work						
b. Dependent Variable: students' attitude towards their group work						
*70 master students in medical school, who co-authored their group work on a wiki						

All learners agreed or strongly agreed that the process of their co-constructive activities was motivating enough to apply their new knowledge and skills into their future academic lives.

Discussion

In this action research, the impacts of the flipped classrooms on master students' wiki-supported group work in a blended course were investigated. Exploring the synergistic effects of flipped classrooms and a wiki-authoring activity on students' group-work, it was confirmed that a wiki-authoring group work is effective in achieving student learning outcomes. A wiki-authoring group work enhances students' attitude towards their group work and integrating a wiki with flipped classrooms increases wiki accomplishment.

In this study, the mean score of both the quantity and quality of students' participation in doing their group work were significantly higher in the wiki-group, compared to those of the students' in the non-wiki group (Sig = 0.000). Similar to our findings, in a study entitled "collaboratively composing an argumentative essay: wiki versus face-to-face interactions", students in wiki collaborative writing group had better performance in drafting and revising an argumentative essay, compared to the students in the face-to-face writing group (15).

Students in the wiki group were more satisfied with the whole course, compared to their peers in the non-wiki group (Sig = 0.000) too. Such a high satisfaction and quality in the wiki group can be related to the

features of our wiki, which were tailored to the students' needs and demands based on the findings from our own reflections and students' feedback. This inference is in contrary to the findings of an action research at the Brunel University in England. In that research, none of the 75 participating undergraduate students had a wiki activity during the first 5 weeks of the study. After 5 weeks, 68 percent of students had just visited the wiki. According to the researchers, unsatisfying features of their wiki were the first and most important reason for their failure(16). Moreover, the positive relationship between higher satisfaction of students and better quality of their group work in our wiki group could be credited not only to the satisfying and customized features of the wiki, but also to the integrative application of wiki with flipped classrooms.

Similarly, in a study conducted Victoria University of Wellington, students in the online group allocated more time to the workgroup than the students in the face-to-face training group(8).

In a study at the University of Griffith in Australia, 180 first year students of psychology did their assignment for the course of the research and statistics on a wiki in groups of 4 to 6. The engagement rate of students in the wiki group was significantly higher than that of the control group; however, the overall student participation rate was not satisfactory from the viewpoint of the researchers because no reward had been considered for the participation of students in doing the homework on the wiki(17). In our study, all students were informed that 40 percent of their overall score would be allocated to their group work. It seems that such a plan for assessment effectively derived students' engagement and learning.

A wiki cannot be used to perform any group work and in any course. A course should require learners to work collaboratively. The activity in the wiki should be also trained and practiced. The courses at the postgraduate level are better choices to pilot wiki usage at universities (8). Given these particulars, we used wiki for master students and for the course of writing articles in English, which requires collaborative learning. These points can be other reasons for the success in using wiki in our study.

In all, the effectiveness of our wiki-authoring activity in achieving student learning outcomes can be credited to satisfying and customized features of the wiki; a significant share of the end-of-semester score to the group work; integrative application of wiki with flipped classrooms; and employment of wiki for master students and for the course of writing articles in English, which requires collaborative learning.

The findings of this study lend evidence that integrating a wiki with flipped classrooms increases wiki accomplishment. In this study, despite the students in the non-wiki group, students in the wiki group were significantly more satisfied with flipped classrooms (sig = 0.028). Furthermore, students' satisfaction with flipped classrooms correlated at $r = 0.485$ (Sig = 0.017) with quality of their participation in doing their group work for 70 students in the wiki group. The effectiveness of the FC approach in increasing students' motivation and engagement is verified by a systematic review(18); however, in another systematic review of the flipped classroom, a contradictory relationship between students' satisfaction with FCs and their academic performance was reported. The second review was focused on nursing

education and according to its authors, such a tension could be attributed to some features of the FC, like group-based activities in FCs(19).

In our study, students in the non-wiki group asked fewer questions and less involved in the discussions on the forum. During the semester, they never asked for the teacher's feedback. In order to complete their group work, they mostly paraphrased the text of the e-contents produced by the teacher, with poor evidence of critical thinking. These findings could justify the negative relationship between satisfactions with flipped classrooms with quality of the group work among students in the non-wiki group. In other words, students in the non-wiki group did not take advantages of collaborative learning and formative assessment for full. While, having more extrinsic motivation derived from peer learning and teacher feedback, students' in the wiki group successfully monitored and regulated their learning processes and developed their meta-cognitive skills. These inferences are in line with the findings of a randomized experimental study, in which the model of positive and significant relations between motivation and formative assessment or meta-cognitive skills are confirmed(20). According to findings of that study, "there is a significant positive effect of peer discussions combined with teacher feedback on both metacognition and motivation"(20).

The findings of this study can be generalized to all millennial students, who are currently studying postgraduate. Given the generational differences between millennial students and Z generation of learners(21), it is recommended to investigate the effectiveness of wiki-authoring activities among students in the new generation Z students. Considering the point that generation Z students are changing our approaches to teaching and learning(22), they may be asked to upload voice files on the wiki(not to type any content).

Conclusions

Based on the findings of this study, including an educational wiki in a blended course and holding the classes with an FC approach can increase wiki accomplishment. Such synergistic impacts of integrating a wiki-authoring activity with flipped classrooms improve both quality and quantity of group works among master students in the medical school. These findings approve the positive role of collaborative and constructivist learning in achieving greater learning outcomes for wiki-supported group works.

Highlights

Collaborating on a wiki reduces the challenges of doing group works.
A wiki-authoring group work enhances students' attitude towards their group work.
A wiki-authoring group work is effective in achieving student learning outcomes.
Collaborating on a wiki activity improves quality of group works among students.
Integrating a wiki with flipped classrooms increases wiki accomplishment.

List Of Abbreviations

CVI: Content Validity Index

CVR: Content Validity Ratio

FC: Flipped Classroom

ICC: Intra-class Correlation Coefficient

LMS: Learning Management System

Moodle: Modular Object-Oriented Dynamic Learning Environment

PHP: Hypertext Preprocessor

Q&As: Questions and Answers

SPSS: Statistical Package for the Social Sciences

Declarations

Ethics approval and consent to participate

Conducting this study was approved by the ethical committee board at our University of Medical Sciences. The approval code is 1396.1129.

All students provided written informed consent to participate. The learning objectives of the studies were clearly shared with experts and participating students. A unique code was assigned to each participant. The participants were told that all the research data will be saved confidential. They were granted the right to withdraw from the study whenever they wanted.

Consent for publication

Not applicable

Availability of data and materials

The wiki is not public and it is open only to the course students. The wiki and all the data, which is generated and analyzed in this study, will be available from the corresponding author upon any reasonable request.

Competing interests

The authors declare that they have no competing interests, except for the point that the correspondent author, Saeideh Ghaffarifar is an associate editor of BMC Medical Education.

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Authors' contributions

SGH and AA conceived and the study. SGH and AHA collected and analyzed the data. All authors interpreted the findings and contributed to the validation study of the satisfaction questionnaire. SGH wrote the first draft of the manuscript. All authors read and critically revised the first draft and confirmed the final version of the manuscript.

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