Findings When Converting a Summative Evaluation Instrument to a Formative One Through Collaborative Learning Activities

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Abstract. Although illiteracy has been in constant decline over the last decades, there are too many reports about people having problems to identify the main ideas contained in texts they read. Reading comprehension is essential for students, because it is a predictor of their academic or professional success. Researchers have developed computer supported learning activities for supporting students develop their reading comprehension skills with varying degrees of success. One of the various advantages of having students work on electronic documents is that computers can help teachers monitor students' work. One of the problems of these systems is poor usability due to sophisticated human-computer interaction paradigms emulating activities students perform in traditional learning activities for improving reading comprehension with pen and paper. In this paper we report on a research which implements a learning activity based on answers with multiple choice similar to a questionnaire, which is easy to implement in computers and easy to interact with. Although multiple choice questionnaires are associated to summative evaluations, the implemented learning activity uses them within a collaborative learning activity in which students have to justify, first individually then collaboratively, their choice with a short text. The developed system was used and evaluated in a real learning situation; one of the most interesting findings is not only that students who have to justify their option with a text perform better than those who have not, but that the pertinence of the text to the question does not play a major role. This suggests that just asking the students to justify their answers requires them to do a thinking process which otherwise they would not do.

Keywords: Reading comprehension · Collaborative learning
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1 Introduction

During last years, statistics show a constant decline in reading and writing illiteracy in the world, and especially in developing countries. For example, the webpage https://ourworldindata.org/literacy/ contains several charts showing how the illiteracy rate has been falling in many countries in all continents. The trend turns dramatically sharp during the second half of the last century.

However, although more people can read a text, the reports are not so encouraging when it comes to reporting results about the understanding that people achieve about the texts they read in their schools [1]. Also, in developed countries we can see same concern about people understanding the content of what they read. As an example, it has been reported that "far too many American students remain poor readers" [2].

In the past, computer-based systems have been developed to support training of reading comprehension with reported good results. In [3] authors identify the advantages of using computer-assisted systems in educational programs for children as motivating factors [4] and tools for obtaining high level of attention [5]. Computer based systems for supporting the improvement of reading skills are mostly aimed at addressing the learning of strategies which experts have identified as conducive to improve reading comprehension [6]. Some of the most used strategies are to have students read a text trying to determine its main message by means of summaries or keywords, have the students construct alternative representations of the text - such as drawings, conceptual maps, mental images - and answer questions about the text [7].

A previous paper presents work based on the strategy of training the reading comprehension by highlighting the words inside a piece of text which represents the key idea contained in it [8]. However, this experience has shown that the approach of using constructed development responses has its disadvantages, especially when applied to massive courses. In this sense, an activity in which the students could respond through the selection of multiple choices would make the whole process easier, since the evaluation of the correctness of the answers becomes simple. Multiple-choice tests have some advantages [9]. However, they also have criticisms [10] related to the fact that a constructed response is supposed to require more complex skills from the student than a multiple-choice answer, thus allowing a student to perform a more demanding and complete learning activity.

On the other hand, authors of [11, 12] show there is equivalence between constructed responses and multiple choices. The justification for this statement is that for these authors, one way for the student to generate a response in a multiple-choice questionnaire is that the student must first build a response, then verify/check against possible alternative responses, thereby doing a significant learning activity.

In various papers, authors describe experiments in which students answering a multiple-choice questionnaire are asked to justify their decision for various reasons, like detecting false positives (choosing the right answer for a wrong reason) [13] or for stressing the student's reasoning process [14].

In this inquiry, we wanted to explore how the need to justify the answer to a multiple-choice questionnaire affects students' performance. Furthermore, we also wanted to study the quality of the comments provided by them. For these purposes, we designed a learning activity in which students had to read texts and answer a multiple-choice questionnaire where they also had to provide a short text justifying their choice for the right answer. This activity was done in 3 phases: first individually; then again individually but after looking at the answers and the justifying texts provided by their groupmates; and finally, discussing the right choice and justifying text with their groupmates having all members of the group to choose a common option. This learning activity was supported by a technological tool named RedCoMulApp which we developed (described in detail in Sect. 3).

The content of this article is organized as follows. Section 2 explains the relevant theories, methods and techniques used as design requirements for the reading comprehension activity converted to a formative activity. Section 3 presents the design of the reading comprehension activity, along with the description of the RedCoMulApp application. Section 4 describes the preliminary experiments and Sect. 5 concludes the paper.

2 From Multiple Choice to Reading Comprehension Learning Activity

In a previous learning activity, students had to read a text in an electronic document displayed on iPads, and mark the words of the text which represent the key idea contained it [8]. However, this experience has shown that the approach of using constructed development responses has its disadvantages, especially when applied to massive courses. Some of these disadvantages are the following:

- It is difficult for students to develop a response built from mobile computer systems.
- It is time-consuming for the teacher to evaluate answers from all the students.
- It is difficult to monitor the degree of progress of the answers given by the students: (a) how many have already responded, and (b) the correctness of the answers.
- It takes much effort and time for the teacher to give appropriate feedback to all students based on their answers.

There were also problems related to Human-Computer Interaction when students had to "mark" with a virtual pen the words of the text displayed by the iPad. In this sense, an activity in which the students can respond through the selection of multiple choices, would make the whole process easier; since the evaluation of the correctness is simple. In fact, according to [10], the advantages of multiple choice tests are:

- They are easy to apply.
- Their results are trustworthy.
- Because they are standardized, they are applied in the same way to all students.
- They are objective.

We can also add that if we are aiming at implementing a computer-based system, multiple-choice tests are easy to build. However, some authors [9, 10] also express some criticisms:

- It is possible to choose the right answer without real knowledge.
- Typically, students do not receive specific feedback, apart from the general results.
- The evaluator could be a non-expert in the subject and decide to take out questions regardless of pedagogic arguments.

The criticisms are related to the fact that a constructed response is supposed to require students' complex skills. Therefore, a student performs a significant learning activity. However, as mentioned above, [11, 12] show there is equivalence between constructed responses to multiple choices. Marsh et al. [13] argue that in a multiple-choice test students not only have to mark the option she/he considers to be the right one but also to justify it.

There is a common test of student selection for almost all universities in Chile, called PSU. An important part of it consists of reading comprehension, measured by multiple-choice questions. This evaluation is summative, that is, it is meant to measure what the students know. Based on [14], it is possible to convert an activity with summative evaluation into a formative one if the evaluation is used as feedback for the student to reflect on and reformulate their original answers. Moreover, this can be done collaboratively to take advantage of the benefits offered by Collaborative Learning (CL) not only in the academic but also in the social and psychological realms [15]:

Social benefits:

- CL helps to develop a social support system for learners;
- CL leads to build diversity understanding among students and staff;
- CL establishes a positive atmosphere for modelling and practicing cooperation; and
- CL develops learning communities.

Psychological benefits:

- Student-centered instruction increases students' self-esteem;
- Cooperation reduces anxiety; and
- CL develops positive attitudes towards teachers.

Academic benefits:

- CL Promotes critical thinking skills;
- CL involves students actively in the learning process;
- Classroom results are improved;
- CL models appropriate student problem solving techniques;
- Large lectures can be personalized; and
- CL is especially helpful in motivating students in specific curricula.

Multiple-choice tests are mainly used for summative evaluations, since often the feedback the student receives is the number of correct answers only and not the explanations. In this inquiry we modified multiple-choice tests to include both aspects mentioned above, namely collaboration and justification of the right option. In particular, we modified the PSU summative evaluation in order to make it a formative evaluation instrument.

2.1 Reading Comprehension

Students who use reading comprehension strategies (such as prediction, think-aloud, text structure, visual representation of text, key words selection, etc.), improve their understanding of the message, identify the essential and relevant parts of it, and/or are able to express opinions or comments [16]. Accordingly, the design of the RedCoMulApp application has the following features:

(1) Use the advantages of **short messages** (microblogging).
(2) Implement **real-time monitoring** to manage the follow-up of the elementary stages.
(3) Implement **collaborative learning** with groups of 2 to 5 students who will work together to answer the multiple choices questionnaire.

In an educational context, **short messages** (microblogging, or tweets) can be used to express ideas, paraphrase or criticize a concept [17]. Short messages provide support for students' collaborative work, since they allow posing questions, share ideas and state answers.

One of the main contributions of software applications as a scaffolding for learning activities is the **real-time monitoring** that the teacher can have on the level of progress and achievement of her students, allowing her to act as a catalyst to produce changes in the educational activity or in pedagogy [18].

Nowadays, university leaders are recognizing the need for **collaborative learning** inside the classroom, to increase student success [19]. The goal of collaborative learning techniques is to support learning for a specific educational objective through a coordinated and shared activity, by means of social interactions among the group members [20, 27]. Research has shown that proper design of collaborative learning tasks can improve motivation levels, ease communication and social interaction [21, 28], support coordination and increase the level of students' learning achievement [22, 23], and support face-to-face work using mobile devices [21, 24, 25].

3 Design of the Reading Comprehension Activity: RedCoMulApp

This section describes the design of the RedCoMulApp collaborative application to support reading comprehension, which can be used under two roles: teacher (Sect. 3.1) and student (Sect. 3.2).

3.1 Teacher's Role

The teacher's role allows creating the learning activity, and a real-time monitoring of the task development. This monitoring allows the teacher to review the progress of the learning activity that students are performing during "Individual", "Anonymous" and "Team Work" phases (phases are presented in the second line of the main window in Fig. 1).

For the **creating of the learning activity**, a teacher performs the following actions using the "Editor" option of the RedCoMulApp (see this option at the top of Fig. 1):

- Input the title of the activity and writing a text specifying the general instructions.
- Upload a text used as a context for the multiple-choice questions.
- Introduce the multiple-choice questions with their corresponding right answers.
- Using the "Users" option, a teacher assigns the students to the activity.
- With the "Groups" option, the teacher assigns the task to work teams, each one composed of two or three students.

For the **real-time monitoring of the task development,** the teacher has access to relevant information during the execution of the learning activity in order to review the progress of the students in each phase by using the "Dashboard" option. For instance, the teacher can know in the "Individual" phase, how many students have chosen the right answers (see the bar diagrams of Fig. 2); or in the "Team work" phase how many work teams have already completed all multiple-choice questions (Fig. 3). The information presented to the teacher will be shown in simple graphic interfaces, such as comparative tables or matrices, bar charts, etc. (Figs. 2 and 3), that are used by the teacher to decide whether to move to the next phase or wait for a significant number of students to complete the current activity stage. In addition, this information allows the teacher to identify the students' level of achievement in each phase, according to answers correctly chosen by the students. For example, if less than 1/3 of the students have successfully completed to answer their questions during the "Individual" phase, then the teacher may proceed to intervene the class, offering feedback to explain the questions, explain the context of the texts, etc. Monitoring and then intervening a face-to-face class can be very effective [29].

Using the "Configuration", "Individual", "Anonymous" and "Team Work" options, the teacher manages the development of the application. In the initial phase of "Configuration", the teacher can create the learning activity.

Then, when the teacher selects the "Go to Next" option (Fig. 1), the phase changes to "Individual", which is when the students receive the text to be read and the questions to answer on an individual basis. Once all the students have finished responding, with the "Go to Next" option the teacher changes the task from "Individual" to "Anonymous"; where the students answer the same questions again but having anonymous access to the answers from two of their classmates (Fig. 4), according to the groups defined with the "Groups" option. Then, the teacher changes phase to "Team Work"

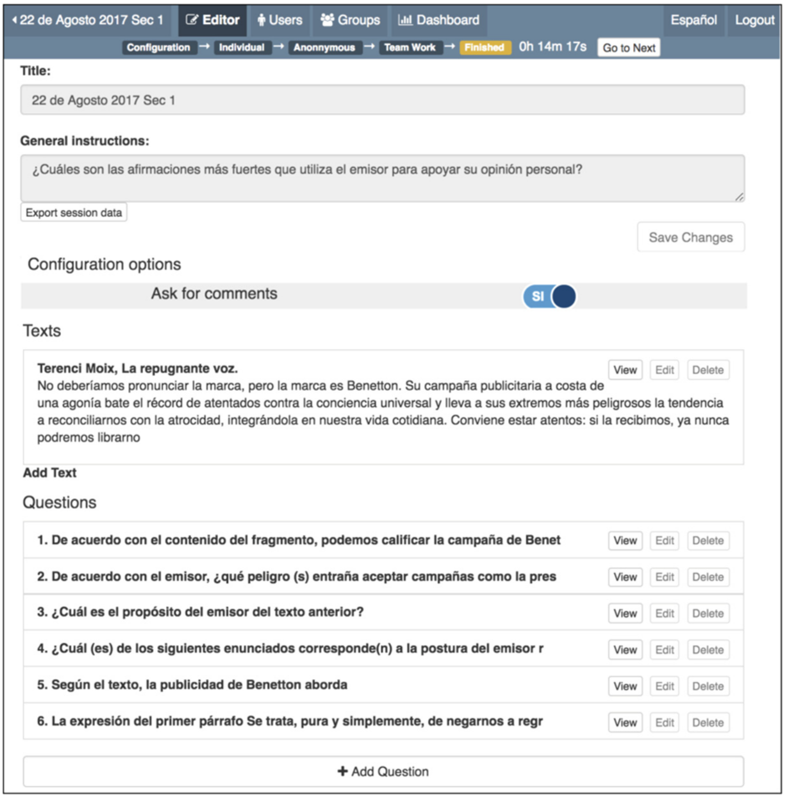

Fig. 1. View of the interface for the teacher's role, showing title of the activity, instructions, the text and the multiple-choice questions with their answers. The task is assigned to the students with the "Users" option. The "Groups" option is used to configure the groups. The teacher monitors the activity using the "Dashboard" option (Fig. 2). The second line shows the phases of the activity. The current one is highlighted in yellow: "Finished". The "Go to Next" option advances from one phase to the following one. (Color figure online)

with the "Go to Next" option. At this stage students meet face-to-face and they answer together the same multiple-choice questions, having access to the answers previously given during the "Individual" and "Anonymous" phases. The students exchange opinions in order to agree on a single answer.

In each of the "Individual", "Anonymous" and "Team Work" phases, the teacher can monitor and manage the activity and performance of students in real time through the "Dashboard" option (Figs. 2 and 3).

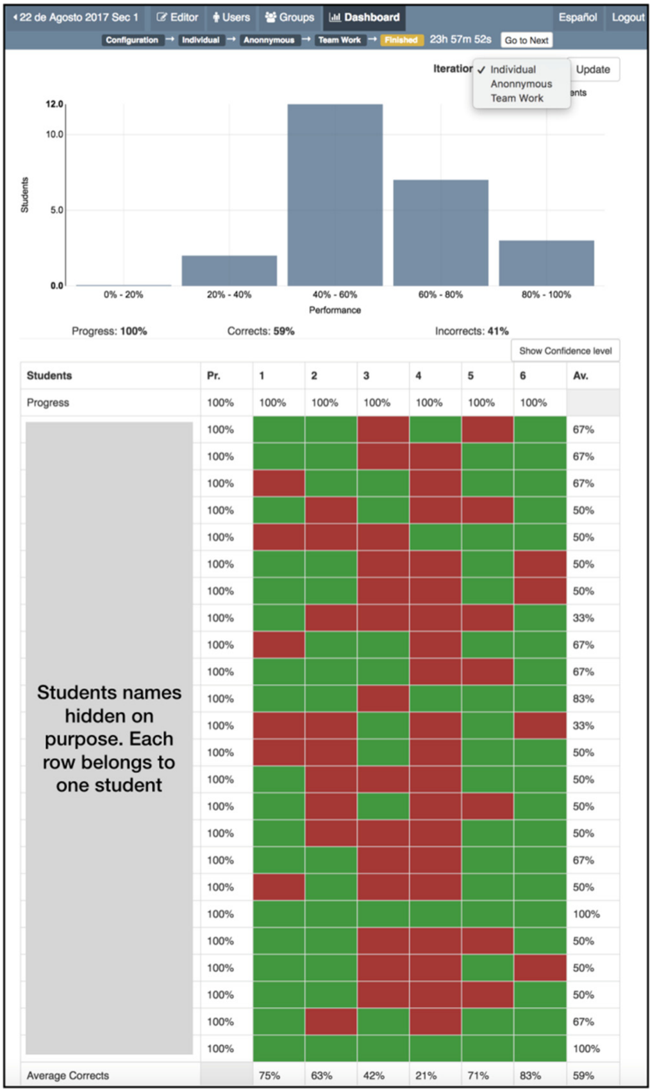

Fig. 2. A view of the monitoring tool showing the performance of the students with the correct answers (green) and the wrong answers (red). This is from an activity performed by 22 students, Sect. 1. The results are of the "Individual" phase, where students got an achievement of 40%–60%. Although this view shows that the RedCoMulApp has finished (status "Finished" in the label), it is possible for the teacher to access the students' performance, since the view is with "Dashboard" option activated, and has chosen the "Individual" phase. (Color figure online)

Fig. 3. Two views of the monitoring tool showing the performance of the students with the correct answers (green) and the wrong answers (red) for "Anonymous" (top view partially covered) and "Team Work" (superimposed bottom view) phases. This capture is from an activity performed by 42 students. The views show the activity has finished. The upper view are the results corresponding to the "Anonymous" stage and the third one to the "Team Work" phase. There is an increase in the students' performance from phase to phase, reaching from 40%–60% and 60%–80% in the "Individual" phase (Fig. 2), 60%–80% in the "Anonymous" phase to 60%–80% and 80%–100% of correct answers in the "Team Work" phase. (Color figure online)

3.2 Stages in the Learning Activity – Student's Role

This section describes the "Individual", "Anonymous" and "Team Work" phases which students should go through with RedCoMulApp in order to accomplish the reading comprehension learning activity in that order. As mentioned above, the teacher decides the moment when to move from one phase to the next one.

"Individual" Phase. At this stage, each student individually reads the text provided by the teacher (left hand side view of Fig. 4). As each student answers the questions, the teacher can see the answers (in green if correct, and in red if it is incorrect) in real time in RedCoMulApp using the "Dashboard", as seen in the left hand side view of Fig. 2.

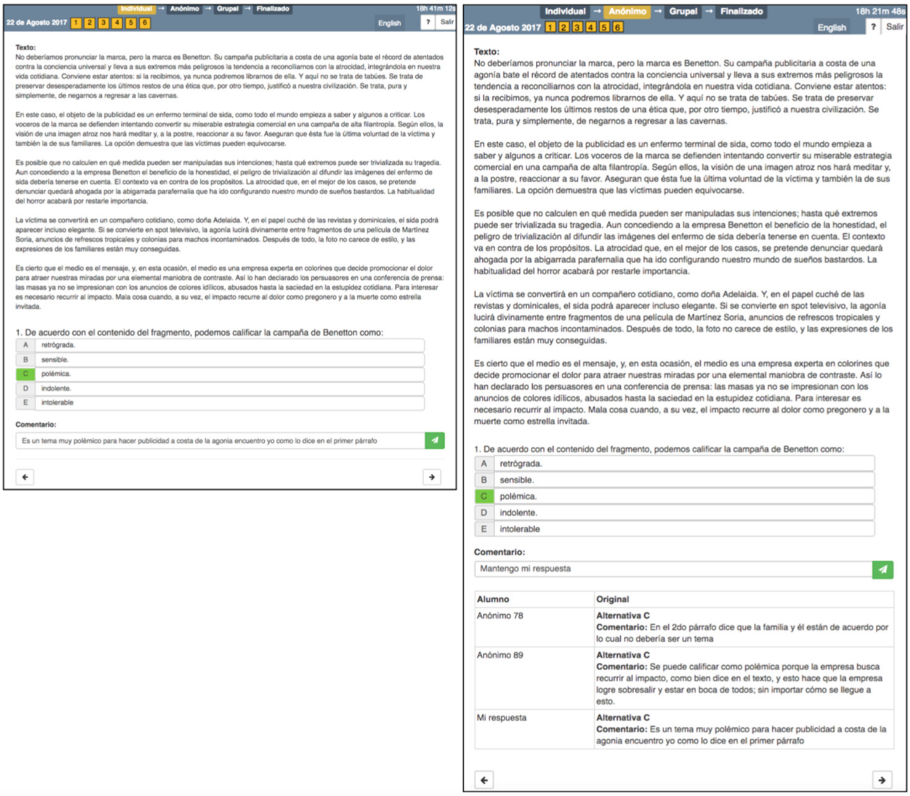

Fig. 4. Two views of the of RedCoMulApp interface in the student's role from a session called "August 22, 2017". At the left, the status in "Individual" phase is highlighted. In the following line labels with numbers 1 to 6 correspond to the six multiple-choice questions of this session. They change color as they are answered. The text to be read is shown in the middle, followed by the first of the 6 questions, along with 5 response options labeled with letters A, B, C, D and E. In this case, the student has selected option C, and in the line below has written a brief justification for his answer. The view on the right corresponds to the "Anonymous" phase, which contains the response of the same student from the view on the left, together with the answers and justifications of his colleagues from whom he receives this information anonymously. (Color figure online)

"Anonymous" Phase. At this stage, students do the same as in the previous stage (reading the text and answering the multiple-choice questions) with the difference that they can see the answers of the other two students of their groups without knowing who they are (see the view on Fig. 4 at the right). Students have then to confirm their previous answer or change them based on what their groupmates have answered.

"Team Work" Phase. At this stage, students see the names of their groupmates and they meet face-to-face to choose a single option together. They can talk to each other, exchange opinions and discuss their disagreements. All students of the group have to select the same option as answer; otherwise, they receive a message from the system to do so.

4 Evaluation of the Reading Comprehension Learning Activity

Subjects and Settings: The evaluation took place at the Faculty of Economics and Business of the University of Chile, with 12th grade students from nine Santiago mid-income high schools, from July to October, 2017 (6 sessions in total, 90 min each). There were 46 students in total, divided in two sections, 22 in the control section and 24 in the experimental section. At the end we used the information associated with 42 students (20 in the control section, 22 in the experimental section) since some of them did not participate in all sessions. Students' age ranged between 15 and 16 years old.

Procedure: In each session, the students worked in a regular classroom during the language class time. During the first session, the teacher gave 5-min basic instructions about the collaborative activity to both control and experimental sections. Students performed a first test activity for 15 min in order to learn how to use the application. This activity consisted in reading a simple short text and answering three questions. After this preparation, students performed the proper activity (intervention), which was recorded by the teacher and three teaching assistants. Each section had six sessions in total.

Activity Description: The activity was designed according to the goals in reading comprehension for students of 12th grade defined by the language area of the Chilean Ministry of Education. Before starting the activity, the teacher explained the methods and techniques of text reading comprehension. Later, during the experimental sessions, students received a 800–900 words text that they had to read and then answer a multiple-choice questionnaire in order to evaluate their level of comprehension of the text they read. In each of the next five sessions, they received a new text to read. The six chosen texts were extracted from the curricular content of the Chilean Ministry of Education along with the corresponding multiple-choice questions. Text and questionnaire were the same for both sections in each session.

In each session, the activity started providing the students with iPads having network access to the RedCoMulApp application, on which they had to log in with their personal account and password. Then, the teacher started the activity on an iPad, activating the "Individual" phase for approximately 20 min, where students individually accessed and read the text. After that, they answered 12–14 associated multiple-choice questions. Once all the students finished this phase, they continued to the “Anonymous” phase for nearly 30 min, where again each student accessed individually the text to answer the same multiple-choice questions as before but having access to the answers of their two groupmates. At this stage, students could confirm their previously selected options or change their answers. Finally, in the “Team Work” phase, which lasted approximately 30 min, the students received from RedCoMulApp the names of their colleagues who in the previous phase saw their answers, and with whom they now meet face to face to answer as a group the same multiple-choice questions. In this phase, students are expected to talk to each other, exchange opinions, and discuss and sort out their disagreements in order to have a group answer.

Both sections (control and experimental) had to perform exactly the same activity except for the experimental section, whose students had to input a short text with an argument justifying the chosen option; the control section did not have to enter any justification.

Results. Comparing the performance in terms of correct answers given by the students who had to justify their answers with a short text (experimental section) with those of the control section, we can see that the difference is statistically significant at 0.000 as shown in Table 1 in favor of the experimental section. This means that students who justified the selection of the option obtained better results.

Moreover, when comparing the correct answers grouped by phase (“Individual”, “Anonymous” and “Team Work”) the difference is also statistically significant at 0.000 in all cases as shown in Table 1. This implies that when having to justify the given answer during the “Individual” stage the experimental section student had to think more the comprehension of the text than the typical student of the control section. This further work resulted in better answers.

On the other hand, during the “Anonymous”, stage the justification text helped the students understand more accurately the selection of answers from their groupmates, with whom they had not talked yet. Finally, during the “Team Work” stage the collaborative work with their groupmates, from whom they already knew their justifications enriched even more their own decision when selecting the right answer.

We also analyzed the quality of the justification given by the students of the experimental section; that is, the degree to which they related the arguments written in relation to whether it covers all the dimensions required for the selection of their answers, whether correct or incorrect. For this analysis, we rated the quality of the justifications to support the selected answers in all 6 sessions, and in all the stages “Individual”, “Anonymous” and “Team Work” of the experimental section.

The justification was rated in one of three categories (see Table 2): (a) **Insufficient:** It fails to cover any of the dimensions or elements of the response or choice made, or simply, there was no evidence of coherence between the central idea and the given answer. (b) **Partially Sufficient:** It covers some elements or dimensions of the response or choice made. It is on the right track, but it does not give an adequate justification involving the given answer. (c) **Sufficient:** The given justification is good enough to justify the selected answers. They are in total coherence and can give relevant arguments for their selection.

Table 1. Description of the results, comparison between answers without and with justifications.

Descriptive statistics			
Justifications	*Answers*	*Frequency*	*Valid percentage*
Without justifications (Control section)	Incorrect	781	45.2
	Correct	946	**54.8**
	Total	1,727	100.0
With justifications (Experimental section)	Incorrect	597	32.7
	Correct	1,226	**67.3**
	Total	1,823	100.0
Comparative statistics			
Contrast statistics	*Value for the correct answers figure*		
U of Mann-Whitney	2755577.000		
W of Wilcoxon	8722362.000		
Z	−8.763		
Sig. asintot. (bilateral)	**.000**		
Comparison of correct answers between control and experimental grouped by phases			
Phase	*Contrast statistics*	*Correct answers*	
"Individual"	U of Mann-Whitney	418677.000	
	W of Wilcoxon	1389598.000	
	Z	−7.248	
	Sig. asymptote (bilateral)	**.000**	
"Anonymous"	U of Mann-Whitney	206804.000	
	W of Wilcoxon	452154.000	
	Z	−5.360	
	Sig. asymptote (bilateral)	**.000**	
"Team Work"	U of Mann-Whitney	255944.500	
	W of Wilcoxon	1182785.500	
	Z	−3.541	
	Sig. asymptote (bilateral)	**.000**	

Table 2. Classification of quality of the justifications written by the students of the experimental section in all stages. It is important to note that the number of comments will not match the total of justified answers, because only non-repeated justifications are taken into account, since several were re-used and others were new in subsequent stages such as the "Anonymous" and "Team Work"

Session	#comments	Insufficient	Partially sufficient	Sufficient
1	592	93%	4%	3%
2	397	89%	6%	5%
3	433	88%	9%	3%
4	405	90%	7%	3%
5	449	83%	13%	4%
6	265	86%	10%	4%

Given the results shown in Table 2, we can conclude that the justifications written by the students do not sustain (or are insufficient) for building an argument justifying the decision made when selecting an option. However, it seems the intent of doing it positively influenced the selection made.

5 Conclusions

The results of the experiment confirmed that the learning activity supported by Red-CoMulApp presented in this paper effectively supports the improvement of the students' reading comprehension. Its design was based on converting a summative evaluation learning activity into a formative one using a mechanism which is easy to implement and use.

We can infer that students' performance is positively influenced by their comments production, regardless of their quality. It seems that the cognitive effort of trying to make a statement makes the students choose better answers than those who do not have to produce comments. Will they spend more time thinking on the answers? Will they use upper level cognitive processes? Nevertheless, we did not observe a correlation between the cognitive process of generating short texts and the quality of these texts. The existing positive correlation is between the cognitive process and the text generation process.

It is interesting to observe answers such as "I believe…", or "I think…", or "In my opinion…". These statements seem to validate the widespread existence of the post truth; i.e., the validity of just saying something or based on "my opinion" as a foundation for decisions. The new pedagogic scenario should take into account this post truth belief in which "my opinion" really matters and creates a reality [26].

Another observation is that the apparent widespread availability of "emojis" is introducing a new way of communication, which is not understandable by the traditional analysis of text production.

Thanks to the new technologies, especially mobile devices, people are writing many more characters today than in the past. We can imagine the number of characters a person daily writes for communicating through Whatsapp, Facebook and other social network applications is large by observing them in everyday life. However, we cannot guarantee that people are writing better than in the past. Results obtained in this work tend to show the contrary. Perhaps, a new communication paradigm is emerging, which is worth to study.

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References

1. Mullis, I.V., Martin, M.O., Foy, P., Drucker, K.T.: PIRLS 2011 International Results in Reading. ERIC (2012)
2. Slavin, R.E., Cheung, A., Groff, C., Lake, C.: Effective reading programs for middle and high schools: a best-evidence synthesis. Read. Res. Q. **43**(3), 290–322 (2008)

3. Rosas, R., Escobar, J.P., Ramírez, M.P., Meneses, A., Guajardo, A.: Impact of a computer-based intervention in Chilean children at risk of manifesting reading difficulties/Impacto de una intervención basada en ordenador en niños chilenos con riesgo de manifestar dificultades lectoras. Infancia y Aprendizaje **40**(1), 158–188 (2017)
4. Wild, M.: Using computer-aided instruction to support the systematic practice of phonological skills in beginning readers. J. Res. Read. **32**(4), 413–432 (2009)
5. Karemaker, A.M., Pitchford, N.J., O'Malley, C.: Does whole-word multimedia software support literacy acquisition? Read. Writ. **23**(1), 31–51 (2010)
6. Dole, J.A., Duffy, G.G., Roehler, L.R., Pearson, P.D.: Moving from the old to the new: research on reading comprehension instruction. Rev. Educ. Res. **61**(2), 239–264 (1991)
7. Sung, Y.-T., Chang, K.-E., Huang, J.-S.: Improving children's reading comprehension and use of strategies through computer-based strategy training. Comput. Hum. Behav. **24**(4), 1552–1571 (2008)
8. Zurita, G., Baloian, N., Jerez, O., Peñafiel, S.: Practice of skills for reading comprehension in large classrooms by using a mobile collaborative support and microblogging. In: Gutwin, C., Ochoa, S.F., Vassileva, J., Inoue, T. (eds.) CRIWG 2017. LNCS, vol. 10391, pp. 81–94. Springer, Cham (2017). https://doi.org/10.1007/978-3-319-63874-4_7
9. Gunderman, R.B., Ladowski, J.M.: Inherent limitations of multiple-choice testing. Acad. Radiol. **20**(10), 1319–1321 (2013)
10. Park, J.: Constructive multiple-choice testing system. Br. J. Educ. Technol. **41**(6), 1054–1064 (2010)
11. Rodriguez, M.C.: Construct equivalence of multiple-choice and constructed-response items: a random effects synthesis of correlations. J. Educ. Meas. **40**(2), 163–184 (2003)
12. Bennett, R.E., Rock, D.A., Wang, M.: Equivalence of free-response and multiple-choice items. J. Educ. Meas. **28**(1), 77–92 (1991)
13. Marsh, E.J., Lozito, J.P., Umanath, S., Bjork, E.L., Bjork, R.A.: Using verification feedback to correct errors made on a multiple-choice test. Memory **20**(6), 645–653 (2012)
14. Tamir, P.: Some issues related to the use of justifications to multiple-choice answers. J. Biol. Educ. **23**(4), 285–292 (1989)
15. Laal, M., Ghodsi, S.M.: Benefits of collaborative learning. Procedia-Soc. Behav. Sci. **31**, 486–490 (2012)
16. Duke, N.K., Pearson, P.D.: Effective practices for developing reading comprehension. J. Educ. **189**(1/2), 107–122 (2008)
17. Prestridge, S.: A focus on students' use of Twitter–their interactions with each other, content and interface. Act. Learn. High. Educ. **15**(2), 101–115 (2014)
18. Dufresne, R.J., Gerace, W.J., Leonard, W.J., Mestre, J.P., Wenk, L.: Classtalk: a classroom communication system for active learning. J. Comput. High. Educ. **7**(2), 3–47 (1996)
19. Adams Becker, S., Cummins, M., Davis, A., Freeman, A., Hall Giesinger, C., Ananthanarayanan, V.: NMC Horizon Report: 2017, Higher Education Edition (eds.). The New Media Consortium, Austin (2017)
20. Zurita, G., Nussbaum, M.: Computer supported collaborative learning using wirelessly interconnected handheld computers. Comput. Educ. **42**(3), 289–314 (2004)
21. Baloian, N., Zurita, G.: MC-supporter: flexible mobile computing supporting learning though social interactions. J. UCS **15**(9), 1833–1851 (2009)
22. Blasco-Arcas, L., Buil, I., Hernández-Ortega, B., Sese, F.J.: Using clickers in class. The role of interactivity, active collaborative learning and engagement in learning performance. Comput. Educ. **62**, 102–110 (2013)
23. Carpenter, J.P.: Twitter's capacity to support collaborative learning. Int. J. Soc. Media Interact. Learn. Environ. **2**(2), 103–118 (2014)

24. Zurita, G., Baloian, N., Baytelman, F.: A face-to-face system for supporting mobile collaborative design using sketches and pen-based gestures. In: 10th International Conference on Computer Supported Cooperative Work in Design, CSCWD 2006. IEEE (2006)
25. Zurita, G., Baloian, N.: Handheld-based electronic meeting support. In: Fukś, H., Lukosch, S., Salgado, A.C. (eds.) CRIWG 2005. LNCS, vol. 3706, pp. 341–350. Springer, Heidelberg (2005). https://doi.org/10.1007/11560296_27
26. Aparici, R., Marín, D.G.: Comunicar y educar en el mundo que viene (in Spanish). GEDISA (2017)
27. Collazos, C., Guerrero, L., Pino, J.A., Ochoa, S., Stahl, G.: Designing collaborative learning environments using digital games. J. Univers. Comput. Sci. **13**(7), 1022–1032 (2007)
28. Gallardo, T., Guerrero, L., Collazos, C., Pino, J.A., Ochoa, S.: Supporting JIGSAW-type collaborative learning. In: 36th Hawaii International Conference on System Sciences (HICSS 2003). IEEE Press (2003)
29. Baloian, N., Pino, Jose A., Hardings, J., Hoppe, H.U.: Monitoring student activities with a querying system over electronic worksheets. In: Baloian, N., Burstein, F., Ogata, H., Santoro, F., Zurita, G. (eds.) CRIWG 2014. LNCS, vol. 8658, pp. 38–52. Springer, Cham (2014). https://doi.org/10.1007/978-3-319-10166-8_4