An exploratory study examining 10th-grade students' conceptions about mountain building and relief

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Abstract. Mountain building is a subject that has not been thoroughly explored in relation to misconception research. However, mountain building is complex, involving not only endogenous processes, but also exogenous ones. The main objective of this contribution is to determine, from a holistic standpoint, the misconceptions that students hold concerning mountain building. We have designed and used a questionnaire posing three kinds of questions to students related to their: geological knowledge, emotional issues, and academic background. The main benefit offered by the present research is the identification of misconceptions not covered in the literature available. We have found that the most common misconception is that the mountains occurs only at the edge of convergent lithospheric plates and is less frequent at divergent edges. Some students related the edge of the plates to areas under the sea or on the coast.

1 Introduction

Misconceptions related to the Geosciences, such related to other natural and experimental sciences, are common among students [1]. Perhaps many are related with the difficulties in understanding geological time and the rate of the geological processes. Cognitive psychology has shown that students build knowledge based on previous concepts [2-5]. If the initial perception is inaccurate, the students will have many problems developing more sophisticated understandings of scientific concepts. Moreover, misconceptions could be also a key at an initial point of a didactic sequence, as occurs in the conceptual-change methodology [6]. Affective factors, including motivation, interest and satisfaction are also variables that have been shown to intervene in conceptual-change [7]. Therefore, further misconception research is needed, which also include this affective factor point of view.

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Mountain building is a subject that has not been thoroughly explored in relation to misconception research. The few misconceptions with some connections to this topic have been published in research focused on plate tectonics [1,8]. However, mountain building is complex, involving not only endogenous processes (tectonic plates, faults and folds, magmatism, metamorphism, and isostasy), but also exogenous ones (erosion, transport, and sedimentation).

The main objective of this contribution is to determine, from a holistic standpoint, the misconceptions that 10th grade students hold concerning mountain building.

2 Method

The present study has been carried out with a 10th grade class-group, with a total of 25 students (19 boys and 6 girls) located in the Granada city center, in a middle-class neighbourhood. We have designed and implemented a questionnaire (open and Likert-scale) posing three kinds of questions to students related to their: geological knowledge, emotional issues, and academic background (Table 1). A rubric to assess a question about mountain building (text+ drawing) has also been designed [9].

Table 1. Questionnaire.

How does the mountain building occurs? Answer with a drawn and an explanatory text. You could use the following concepts (actions) to answering the question. *Plates tectonic action; Wind action; Human action; Animals; Water cycle; Erosion; Faults and folds; Inner force of the Earth; Rock Mass; Meteorites; Sedimentation; Temperature; Earthquakes; Transport; Vegetation; Valley; Volcanism*					
Gender: Studies (sciences studies / social or humanities studies): Science score (very bad /bad / regular/ good / very good):					
	1	**2**	**3**	**4**	**5**
1. How does the student feel when dealing with geological topics?	Very insecure	Insecure	Neutral	Secure	Very secure
Justify your answer:					
2. Does the student remember mountain building as a topic in academic courses?	No, I just invented the answer	No, but I saw documental	Yes, but I don´t remember	Yes, I remember	Yes, I remember very well
Justify your answer:					
3. How does the student feel about each answer	Very bad	Bad	Regular	Good	Very Good
Justify your answer:					
4. Was this topic important to understand?	No, it is not useful	It is not important	It is important	It is important, and I am interested	It is very important and I think we should to learn more in class
Justify your answer					

3 Results

The student, in their explanations, mostly appoint to plate tectonics (92%). Nevertheless, these, maybe is merely nominative, since is not found a full appropriate interpretation which include internal and external process. Thus, misinterpretation of plate tectonics are commons as shown answer such "*The tectonic plates have relation with the sea or seaside, because the plate limits are below the sea*" or "*The mountain building are created by the tectonic plates movements, when they separate in divergent boundaries, where the inner energy of the Earth and magma sprout. This magma is cooled and new geographical characteristics are formed, such as the mountains*".

Erosion (60%), volcanism (56%) and earthquakes (40%- maybe unsurprised low proportion since the "popularity" of this phenomenon) are also claimed although not in the proper way (e.g. "I think by erosion, transport and sedimentation, because from young ages teach us this" or "*When Earthquake occurs, part of the mountains are destroyed and a volcano can sprout from the inner of the Earth during years*"). Although in a low proportion (20%), is noteworthy than humans are claimed to be a factor in the mountain building process.

The student drawings, some of them are in figure 1, maybe reflect better than the text the student conceptions about mountain building. Thus, misconceptions arise better from these drawing.

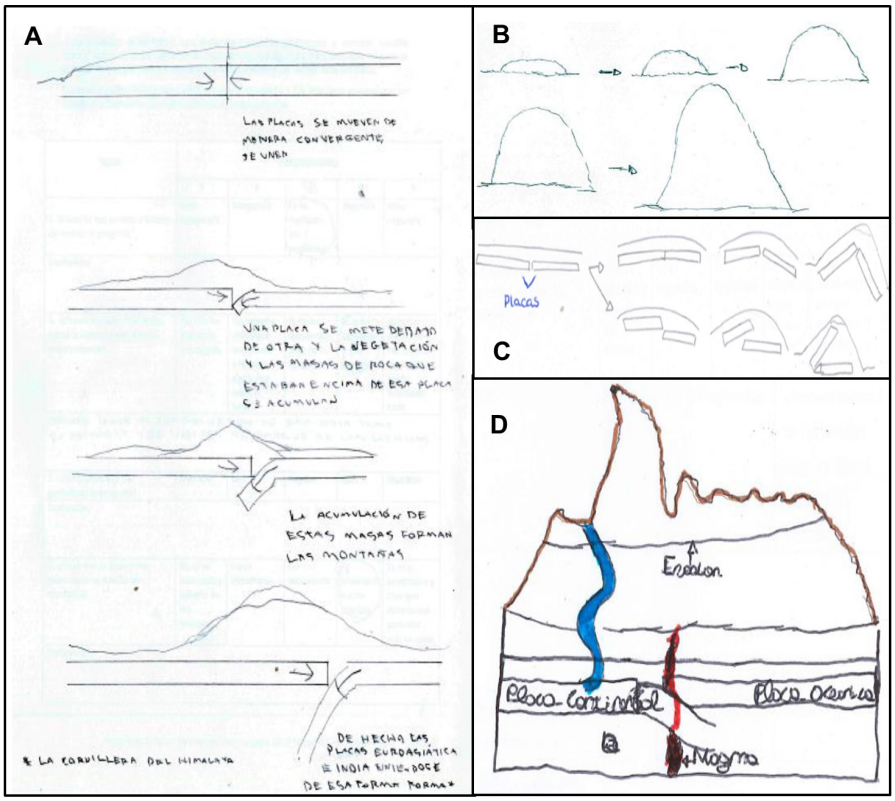

Fig. 1. Student´s drawings that reflect misconceptions. A) Mountains only forms during a process in convergent boundaries; B) Mountains form by the piling up of pieces of rock; C) Mountains are only formed when the edge of one tectonic plate is pushed upward, and one tectonic plate is pushed downward; D) Mountains forms in only one stage.

An analysis of the text with the student explanation and their drawings let the recognition of nine misconceptions about mountain building (table 2).

Table 2. Misconceptions categorized in student responds (text + drawing).

Misconceptions		N
A	Relief in general and the mountains in particular are very stable characteristics of the crust that scarcely change over time [9]	2
B	Mountains form by piling up of pieces of rock [1]	6
C	Mountain building occurs very rapidly and is releated to catastrophic events [1]	5
D	Mountains are volcanoes [10]	11
F	Earthquake and other natural disasters cause tectonic plates movement [1]	4
G	Convection currents cause tectonic plates movement [1]	9
H	Tectonic plates crash below the sea or close to seaside (this research)	2
I	Mountains only forms in convergent boundaries (this research)	4
J	Mountains only forms in divergent boundaries (this research)	12

The majority of these misconceptions have already described in the literature [1,10]. Nevertheless, we detect three misconceptions, up to the author's knowledge, not described in the literature.

The assessment with the rubric show results up to 7 points of ten (25%). That's best answers mean that the student relate mountain building with plate tectonics, with the internal forces plus another relevant process; the students also mention plate tectonic boundary, but no described them, nor offer an example; in addition, all show at least one misconception include in table 2. The lowest score was 1, and 4.8 the average.

Regarding to the emotional answers, 30% of the students felt very secure answering the geological question and they believed they have answered the question well; 20% of the students affirm that they have felt insecure to the time to answer. The rest of participants, the majority of the participants, felt neutral (not secure, not insecure). Although the former group usually shows the most coherent responses, still they have one to five misconceptions. These, mainly "mountains only forms only in divergent boundaries" and "mountains are volcanoes", are also the most frequent misconceptions among other participants (Table 2). The 92% of the student recognized mountain building as a topic in academic previous courses. It has been observed that there are not correlation between number of misconceptions and science score, neither between number of misconceptions and gender. Additionally, mostly all participants, considered mountain building a relevant topic to understand.

4 Discussion and conclusions

We conclude that the studied population, which results could probably be extrapolated to average 10th grade student, had a poor understanding of mountain and relief building. They commonly showed several misconceptions. Thus, up to nine different misconceptions have been identified, three of them new published in this study. On the other hand, the emotional questions suggest that the misconceptions identified in this study are deeply rooted. In fact, many the students felt sure about their answers, they remembered mountain building as a subject of study, but still had the misconceptions.

The origin of the misconception recorded in this study could be diverse. The idea of the catastrophic origin of mountain building could be related to mass media (cartoons, films...). The concept of mountain building as only a fast event located at the convergent plate edges might result from the figures typically used in science textbooks with little or no discussion of the duration of geological processes, in combination with the student's misunderstanding of geological time, which many authors have proved to occurs [1, 10, 11].

References

1. M. Francek, Int. J. Sci. Edu. **35**, 31-64 (2013).
2. R. Driver, G. Erickson, Stud. Sci. Edu. **10**, 37-60 (1983)
3. T. Patchen, A. Cox-Petersen, Sci. Edu. **92**, 994-1014 (2008).
4. C. Kalina, K.C. Powell, Edu., **130**, 241-250 (2009).
5. F. Savasci, D.F. Berlin, J. Sci. Teach. Edu. **23**, 65-86 (2012).
6. M. Limon, L. Manson, *Reconsidering conceptual change: Issues in theory and practice*. (Kluwer Academic Publisher, 2002)
7. P. Pintrich, R. Marx, R. Boyle, Rev. Educa. Res., **63**, 167-199 (1993).
8. R. Mills, L. Tomas, B. Lewthwaite, Int. Res. Geogr. & Envir. Edu., **26**,297-310 (2017).
9. A.M. Velez-Felipe. *Investigación sobre las ideas previas en la formación del relieve*. (UGR, Unpublised MSC Thesis 2018)
10. E. Pedrinaci-Rodríguez. *Los procesos geológicos internos*. (Síntesis, 2001)
11. C. D. Czajka, D. McConnell, J. Geo. Edu., **66**, 231-245 (2018)