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TRADING CARD GAMES AND ENVIRONMENTAL EDUCATION: DEVELOPING STUDENT'S AWARENESS ON ELASMOBRANCHS AND THEIR CONSERVATION

TRADING CARD GAMES (JOGOS DE CARTAS COLECIONÁVEIS) E EDUCAÇÃO AMBIENTAL: CONSCIENTIZANDO ALUNOS SOBRE ELASMOBRÂNQUIOS E SUA CONSERVAÇÃO

TRADING CARD GAMES (JUEGOS DE CARTAS COLECCIONABLES) Y EDUCACIÓN AMBIENTAL: DESARROLLO DE LA CONCIENTIZACIÓN DE LOS ESTUDIANTES SOBRE LOS ELASMOBRANQUIOS Y SU CONSERVACIÓN

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Abstract
The relationship established between popular media and elasmobranchs, especially sharks, is barely sympathetic and generally includes a common-sense idea of terrible ocean creatures that are a threat to human life. Elasmobranchs are threatened, and the preservation of these animals has been a matter of concern to conservationists worldwide. This study was dedicated to developing, applying, and testing a teaching activity using Trading Card Game cards (*Magic: The Gathering, Pokémon, Yu-Gi-Oh!*) in school and university students, aiming to investigate how pop culture can promote students' affection and awareness about sharks and rays and their conservation. The results suggest that using popular culture to develop teaching practices is an effective strategy for raising awareness about elasmobranchs and conservation issues.

Keywords: Chondrichthyes; Endangered species; Ichthyology; Pop culture; Science teaching.

Resumo
A relação entre as mídias e os elasmobrânquios, especialmente os tubarões, geralmente inclui uma ideia de terríveis criaturas marinhas que ameaçam a vida humana. Os elasmobrânquios estão ameaçados e a preservação deles tem sido motivo de preocupação para conservacionistas em todo o mundo. Este estudo dedicou-se a desenvolver, aplicar e testar uma atividade de ensino utilizando Trading Card Game (*Magic: The Gathering, Pokémon, Yu-Gi-Oh!*) em alunos de escola e universidade, objetivando investigar como a cultura pop pode promover o afeto e a conscientização dos alunos sobre tubarões e raias e sua conservação. Os resultados sugerem que usar a cultura pop para desenvolver práticas de ensino é uma estratégia eficaz para aumentar a conscientização sobre elasmobrânquios e questões de conservação.

Palavras-chave: Chondrichthyes; Cultura pop; Ensino de Ciências; Espécies ameaçadas; Ictiologia.

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Resumen
La relación entre los medios de comunicación y los elasmobranquios, especialmente los tiburones, incluye generalmente una idea de terribles criaturas marinas que amenazan la vida humana. Los elasmobranquios están en peligro de extinción y su preservación ha sido motivo de preocupación para los conservacionistas del mundo. Este estudio tuvo como objetivo desarrollar, aplicar y probar una actividad de enseñanza utilizando Trading Card Game (*Magic: The Gathering*, *Pokémon*, *Yu-Gi-Oh!*) en escolares y universitarios, con el objetivo de investigar cómo la cultura pop puede promover el afecto de los estudiantes y sensibilización sobre tiburones y rayas y su conservación. Los resultados sugieren que el uso de la cultura pop es una estrategia eficaz para crear conciencia sobre los elasmobranquios y conservación.

Palabras clave: Chondrichthyes; Cultura pop; Enseñanza de Ciencias; Especies em peligro; Ictiología.

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1 Introduction

1.1 Dangerous waters (for elasmobranchs)

Environmental education is an important educational strategy to promote biodiversity conservation worldwide (RAMADOS; POYYA MOLLI, 2011; ARDOIN *et al*., 2020). Environment-focused pedagogical activities about threatened environment and biodiversity are often used to increase awareness of conservation issues (RAKOTOMAMONJY *et al*., 2015). The lack of knowledge and education about different species and their environment help create and increase environment problems and science education is seen as a tool to promote a change of attitude towards the conservation of species (VALDERRAMA-HERNANDEZ *et al*., 2017), specially towards those species that are considered threatened, such as the elasmobranchs.

Sharks and rays (subclass Elasmobranchii) are a diverse group of predominantly marine fishes (although presenting freshwater and estuarine species) comprising more than 1,200 species (COMPAGNO *et al*., 2005; CAMHI *et al*., 2008; NELSON *et al*., 2016). The successful irradiation of this group began 400 million years ago in the early Devonian, with the main existent families appearing between 250-150 million years ago, between the Permian and Jurassic periods (MAISEY, 2012; SIMS, 2015). Elasmobranchs have acquired a variety of morphological and behavioural traits in their evolution placing them among the living organisms with one of the largest amounts of adaptative characteristics (DULVY *et al*., 2017). Such evolutionary uniqueness has allowed them to usually occupy top positions in the food chain (CAMHI *et al*., 2008) and, thus, influencing energy flow dynamics in marine ecosystems (ROFF *et al*., 2016; DAVIDSON *et al*., 2016; DULVY *et al*., 2017; BIRD *et al*., 2018). As K-strategists, elasmobranchs have late sexual maturity producing few descendants and having a life span of decades (JACOBY *et al*., 2011). These features make them more susceptible to massive exploitation, especially due to their populations' low rebound rates (DULVY *et al*., 2014; JABADO *et al*., 2018).

Elasmobranchs, especially sharks, are commercially valuable for their fins, flesh, liver oil, skin, and other body structures (SHIFFMAN; HAMMERSCHLAG, 2014; DULVY *et al*.,

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2017). Thus, millions of sharks are caught and traded in international markets every year (SIMPFENDORFER; DULVY, 2017; MACKERACHER *et al*., 2019). The economic value coupled with the low regeneration capacity of sharks and rays populations and their habitat loss have led to the decline of the elasmobranch populations in the last century, reaching an alarming rate of 24% reduction overall, resulting in many species being classified by the International Union for Conservation of Nature as threatened (DULVY *et al*., 2008; DULVY *et al*., 2014; SHIFFMAN *et al*., 2017). For some species, the decline of populations has reached 90% (FERRETTI *et al*., 2010; GALLAGHER *et al*., 2012).

Such issues raised concerns in the scientific community (BARKER; SCHLUESSEL, 2005; SIMPFENDORFER *et al*., 2011; YATES *et al*., 2016) and triggered several shark conservation campaigns (SHIFFMAN; HAMMERSCHLAG, 2016) and teaching materials and practices that raise public awareness on elasmobranch conservation. Through education it is possible to find ways to connect younger generations with sharks, similarly to what happened with the anti-whaling movement (FRIEDRICH *et al*., 2014). One way to make sharks as charismatic as whales is the affective engagement of children and teenagers with these animals. Elasmobranchs are often represented in the media (films, documentaries etc) in a way that reproduces a negative attitude of the youth towards them. Therefore, promoting teaching practices that include issues related to elasmobranchs conservation is crucial to surpass the lack of knowledge about the role of sharks and rays in the ecosystems and strengthen conservation efforts (TSOI *et al*., 2016).

1.2 Conservation, media, and ludic learning

Research shows the positive effects that education promotes on students' awareness about conservation issues (DE WHITE; JACBSON, 1994; FARMER *et al*., 2007; PATRICK *et al*., 2007; CHEN; TSAI, 2016). Conservation educational programs foster conservation habits and positive attitudes toward the environment (DIMOPOULOS *et al*., 2010; ARSLAN, 2012; RAMÍREZ; SANTANA, 2019). Pedagogic strategies that approach conservation and environmental education are important tools in the formation of environmentally literate citizens, which are more knowledgeable about conservation issues, understand their responsibility regarding the preservation of nature (KNAPP, 2000; SCHELLY *et al*., 2012) and the social, economic and environmental benefits of preserving endangered species. However, the media also plays a major role in how the public comprehend the need for protection of certain species, besides the formal pedagogic tools.

If the portrayal of some species in movies, television, and advertisements can lead the public to unsympathetic attitudes towards them, it is also well documented that media can positively influence conservation through some of its productions (HUGHES, 2011; ROSS *et al*., 2011). For example, TV documentaries starring Steve Irwin are likely to increase the audience's support to wildlife conservation (BROWN, 2010). Elasmobranchii species, especially sharks, are mostly represented by media as a threat to human life and its preservation

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is barely a topic of interest in the news. This situation creates misconceptions and a lack of knowledge about the issues involving the conservation of this group of animals (MUTER *et al*., 2013; NEVES; MONTEIRO, 2014). Previous studies have highlighted how media as the Universal Pictures blockbuster *Jaws* (FRANCIS, 2012; NEFF; HUETER, 2013; CASTRO, 2013; CROSSLEY *et al*., 2014; NEFF, 2014, 2015; MCCAGH, 2015; LERBERG, 2016; MACDONALD *et al*., 2017), the Syfy *Sharknado* film series (ILOULIAN, 2017) and some recent Discovery Channel *Shark Week* documentaries (MYRICK; EVANS, 2014; EVANS, 2015; THALER; SHIFFMAN, 2015; NOSAL *et al*., 2016) can distort the image of sharks and incite fear to the general public. According to O'Bryhim and Parsons (2015), media can play an essential role in promoting conservation, but its coverage about sharks has been controversial, sensationalist, biased and biologically inaccurate, showing a lot of non-factual and fake documentaries, for example.

The media potential to produce both positive and negative attitudes regarding conservation must be considered when thinking about strategies to inform and educate citizens, especially concerning those endangered species that are not always friendly-faced. Pedagogical approaches using media and its ludic features in school are a powerful strategy to increase students' motivation and engagement in learning about conservation. Furthermore, as media elicits students' imagination, they also foster students' ability to think independently and help teachers to access previous knowledge brought to the classroom (COLLETON *et al*., 2016).

Ludic pedagogical activities involve different strategies that comprise interactive situations related to play, but always allowing students to learn defined subjects through their own imagination (VYGOTSKY, 1978). It is trusted that the use of ludic activities connects elements that are already present in students' lives outside of school and inform their conceptions, helping them in the process of deconstructing pre-established misconceptions about the environment and conservation. This process creates room to build up scientific concepts.

The use of ludic strategies can help to deconstruct a terrifying image of sharks, creating a connection between students and these animals. Creating this connection is fundamental in generating future adults that are engaged in the conservation and management of this group of threatened fishes. Despite the misconceptions media often produces about this group of animals, mainstream media can also offer their audience elements of the popular culture that can be used to develop ludic educational activities that can positively influence the youth towards rays and shark's conservation.

1.3 Science teaching: popular elasmobranchs in school

Sharks and rays have been represented in several pop culture media such as movies and cartoons. Charismatic characters from *Jabberjaw*, *Finding Nemo*, *Finding Dory*, *Shark Tale*, among others, integrate the popular imaginary and were possibly created as counternarratives to *Jaws*, the most famous novel of sharks (LERBERG, 2016). The thriller movie *Jaws*, launched

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in 1975, is an adaptation of Peter Bencheley's novel and directed by Steven Spielberg that grossed more than US$ 7 million in its first three days of exhibition (FRANCIS, 2012). The core plot is about a great white shark that threats bathers on the beaches of Amity Island, a New England fictitious island.

Narratives that demonize sharks representing them as man-eaters create a complex relationship between humans and sharks by inspiring terror and fear and can negatively impact conservation efforts (CROWN; DOUBLEDAY, 2017). For example, recreational shark fishing received a significant boost in popularity in 1975 after *Jaws* release (GALLAGHER *et al*., 2017). However, with a correct approach, it is possible to use even these narratives to teach scientific or conservation topics. For example, a year after the movie's release, which popularized Benchley's novel, Andrews and Dexheimer (1976) utilized *Jaws* as a reference to build a six and a half feet papier-mache shark replica with deaf high school students. This activity was an interdisciplinary teaching strategy aiming to motivate students to read and learn about science (ecology and behaviour of sharks, ocean temperatures and currents).

Charismatic characters can also help in demystifying the evil-ferocity of sharks. The 2003 Disney-Pixar motion picture *Finding Nemo* featured several biologically accurate elements (ABBOTT, 2004) and can be used as an effective tool to teach and learn about elasmobranchs or marine biology in general. Haggerty (2005) proposed teaching activities based on this film to discuss zoological themes such as characteristics and life cycles of marine organisms. Berumen (2008) pointed out how movies in the classroom could awaken interest in learning science. For *Finding Nemo*, the author suggested themes in ecology and physiology of marine species that could be explored by teachers of both elementary and high school. Moreover, the movie's plot draws attention to pertinent issues of marine conservation, such as pollution, overfishing and the illegal harvesting of marine animals for the pet trade (YONG *et al*., 2011). Likewise, McClenachan *et al*. (2012) identified four *Finding Nemo* characters inspired by real elasmobranchs: Anchor (hammerhead shark, Sphyrnidae), Bruce (great white, Lamnidae), Chum (Mako shark, Lamnidae) and Mr. Ray (spotted eagle ray, Myliobatidae). The authors defined these and other characters from the movie as charismatic species that can be used as strategic tools to help increase conservation actions toward endangered sea animals.

The *Finding Nemo* sequence, the 2016 Disney-Pixar movie *Finding Dory*, introduced new characters inspired by marine fauna, including the whale shark (*Rhincodon typus*, A. Smith, 1828) Destiny (BRANDÃO *et al*., 2017). Crewe (2018) pointed out that Destiny, the *Finding Nemo* trio of sharks, characters, and elements of these motion pictures provide plenty of learning opportunities for biology and environmental science students of all ages. The popular appeal of *Finding Nemo* films is not limited to the classroom, but also to aquarium fishery hobby (MILITZ; FOALE, 2017; OLIVOTTO *et al*., 2017).

Elasmobranchs are not only present in movies and cartoons, but also in games like *Pokémon*. Mendes *et al*. (2017) identified three creatures of *Pokémon* based on real

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elasmobranchs: Mantyke and Mantine *(Mobula birostris*, Walbaum, 1792), and Sharpedo (Carcharhiniformes). The authors show that *Pokémon* related material can be useful for science teachers in the classrooms for both teaching and the popularization of science, since *Pokémon* is a successful franchise among kids, teenagers, and young adults with numerous games, a TV series, comic books, movies, toys, and a trading card game.

Trading card game (TCG) or collectable card game is a strategy game in which players purchase cards into a collection and create decks to duel with other collectors in matches. Regular card games have been produced since the 14th century, but only in 1993 with the release of *Magic: The Gathering*, a new kind of card game reached widespread acceptance, visibility, and usage across fantasy gamers: the TCG, in which players not only could play with cards but also collect and trade them, since it is not possible to get all the cards at once but a starter deck that could be improved by acquiring new random cards in the booster packs (OWENS; HELMER, 1996; WILLIAMS, 2006). *Magic: The Gathering* was created by Richard Garfield and published by Wizards of the Coast and, after it, several others TCGs were launched as *Spellfire: Master the Magic*, *Star Trek*, *Redemption*, *Sim City*, *Pokémon*, *Digimon*, *Yu-Gi-Oh!*, *The Lord of the Rings*, *Harry Potter*, *Star Wars*, *Fullmetal Alchemist*, *Dragon Ball*, *Cardfight! Vanguard*, *Battle Scenes*, *One Piece*, among others.

TCGs and their market increase every year thanks to low production cost and popularity, since in most cases they are part of a mix of media, represented by card games, TV series, videogames, mangas, books, movies, and other media forms and entertainment products (ITO, 2005). In 2008, for example, the worldwide market for TCGs reached US$ 2.1 billion and North American sales were estimated to be around US$ 800 million (TURKAY *et al*., 2012). In recent years, the market has grown with the increasing popularity of the board game or the digital card game in the e-sports (SAKAJI *et al*., 2020). Currently, the three most popular TCGs are *Magic: The Gathering*, *Pokémon*, and *Yu-Gi-Oh!*, which have online versions and official championships with cash prizes that can reach tens of thousands of dollars or expensive collectable and electronic products.

TCG cards present artworks of characters that are often creatures inspired by real fauna, including sharks and rays. According to Sabatier and Huveneers (2018), “popular and mass media play a vital role in shaping perceptions of human-wildlife interactions and the ability to co-exist with wildlife” (p. 339). Thus, coupling the aims of making the public aware about conservation issues as well as the power of pop culture in catching people’s attention, this study used trading card games to investigate how pop culture can promote student’s affection and awareness about elasmobranchs and conservation issues.

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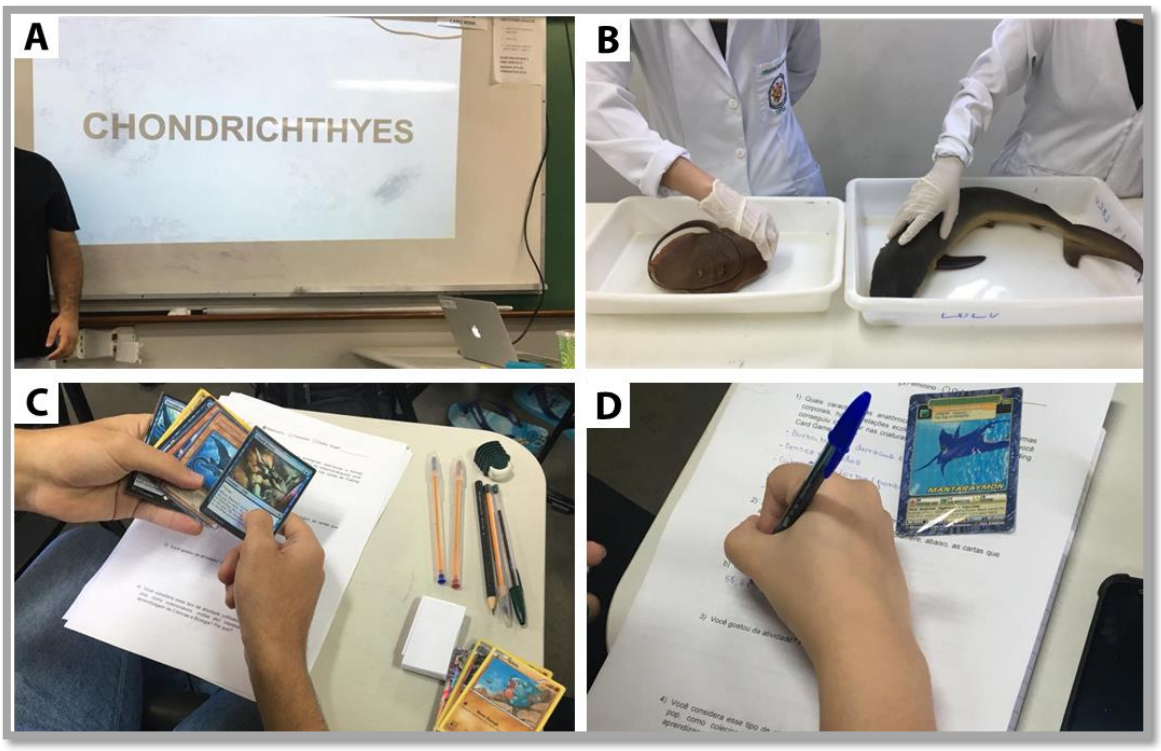
2 Methodological Procedures: Framed Creatures, Free Creativity

An activity using TCG cards was conducted with elementary students of a public school, and biological sciences undergraduate students of a public university, both institutions in the coastal area of southeastern Brazil. This study had the consent of students, teachers, and the school. Participant's identities have been preserved, so information such as name, individual age, face pictures, and institution name or location are not disclosed here. The students could also stop participating at any time during the activity and could choose not to participate.

After a lecture in which students had learned about elasmobranchs and examined fixed specimens, students were divided into nine working groups and each of them received 17 TCG cards from *Yu-Gi-Oh!*, *Pokémon*, *Magic: The Gathering*, *Cardfight! Vanguard*, and *Digimon*. A total of 80 different cards were used (see Appendix). The students were asked to find traits of the fictional creatures which could characterize them as Elasmobranchii. Some cards had creatures that were not exactly inspired by an elasmobranch but had characteristics of this subclass. Then, participants answered a questionnaire about the activity (Figure 1).

Figure 1: Photos of the activity. **A:** lecture about fishes focusing on Chondrichthyes; **B:** students examining elasmobranch specimens fixed in alcohol 70%; **C:** student analysing TCG cards; and **D:** student answering the questionnaire.



Source: photographed and made by the authors.

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The questionnaire was prepared with four open-ended questions:

• Which anatomical and ecological characteristics – structures and body shapes, habitat, ecological relations – of elasmobranchs can you identify in the creatures presented in the TCG cards?;

• Behind each card there is a number. List below the cards that feature creatures inspired A: in sharks, and B: in rays;

• Did you enjoy the activity? Why?;

• Do you think this type of activity – using elements of pop culture, such as collectables, media, etc. – is interesting for the teaching-learning process of science and biology? Why?

After data collection, content analysis was conducted to analyze and categorize the answers (BARDIN, 2013). Content analysis is based on systematic and objective procedures aiming to describe and categorize messages. The steps taken to conduct the analysis were: superficial and intuitive reading of the answers; determining registration units, a clipping unit (defined by a word or a phrase) from which the whole text was segmented for analysis; definition of themes; defining categories from emerging themes; data treatment (i.e., percentage calculation) and presentation of the results based on the created categories in tables and graphs. Thus, the content analysis was used to organize, code the data, and analyse the content on participants' thoughts and ideas.

3 Results: Creatures of TCG, Sharks and Rays of the Sea

Sixty-three Elementary School students (average age = 13.4) identified 25 different morphological and ecological characteristics of elasmobranchs, being ventral mouth (n = 38) and gills slits (n = 35) the most mentioned ones. At the university level, 56 students (average age = 21.4) identified 45 different elasmobranch's traits in the TCG cards, being heterocercal tail and gills slits (n = 45) and fusiform body (n = 44) the most cited ones (Table 1).

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Table 1: Characteristics of elasmobranchs identified by elementary school and university students in TCG cards. The table also shows the gross number of answers (n) and the percentage of students who gave such answer (%).

Characteristics	Elementary School		University		Total	
	n	%	n	%	n	%
Various sizes and shapes	1	1.6	1	1.8	2	1.7
Fusiform body	13	20.6	44	78.6	57	47.9
Elongated body	1	1.6	0	0.0	1	0.8
Flat body	23	36.5	3	5.4	26	21.8
T-shaped head of hammerhead shark	23	36.5	24	42.9	47	39.5
Elongated rostrum with modified placoid scales of sawfish	0	0.0	3	5.4	3	2.5
Dark colour on dorsal region and lighter on ventral region	25	39.7	38	67.9	63	52.9
Lateral line	0	0.0	3	5.4	3	2.5
Skeleton	4	6.3	0	0.0	4	3.4
Cartilaginous skeleton	17	27.0	9	16.1	26	21.8
Cranial kinesis	0	0.0	4	7.1	4	3.4
Fins	11	17.5	8	14.3	19	16.0
Dorsal fins	0	0.0	17	30.4	17	14.3
Pelvic fins	0	0.0	10	17.9	10	8.4
Caudal fin	0	0.0	9	16.1	9	7.6
Anal fin	0	0.0	9	16.1	9	7.6
Pectoral fins	0	0.0	8	14.3	8	6.7
Large pectoral fins	8	12.7	34	60.7	42	35.3
Pointed fins	24	38.1	25	44.6	49	41.2
Even and odd number of fins	0	0.0	4	7.1	4	3.4
Tail	6	9.5	0	0.0	6	5.0
Heterocercal tail	31	49.2	45	80.4	76	63.9
Whip-shaped tail	22	34.9	33	58.9	55	46.2
Sting	1	1.6	3	5.4	4	3.4
Gill slits	35	55.6	45	80.4	80	67.2
Lateral gill slits	0	0.0	15	26.8	15	12.6
Ventral gill slits	0	0.0	13	23.2	13	10.9
Spiracles	0	0.0	1	1.8	1	0.8
Nostrils	0	0.0	4	7.1	4	3.4

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Ampullae of Lorenzini	0	0.0	2	3.6	2	1.7
Mouth	1	1.6	0	0.0	1	0.8
Ventral mouth	38	60.3	39	69.6	77	64.7
Jaw	0	0.0	3	5.4	3	2.5
Cephalic lobes	0	0.0	5	8.9	5	4.2
Teeth	4	6.3	3	5.4	7	5.9
Triangular teeth	20	31.7	29	51.8	49	41.2
Serrated teeth	0	0.0	24	42.9	24	20.2
Tooth series	8	12.7	12	21.4	20	16.8
Eyes	2	3.2	0	0.0	2	1.7
Lateral eyes	0	0.0	7	12.5	7	5.9
Dorsal eyes	0	0.0	6	10.7	6	5.0
Electric shock as a defensive mechanism	0	0.0	3	5.4	3	2.5
Live in water	10	15.9	30	53.6	40	33.6
Live in sea	0	0.0	3	5.4	3	2.5
Swimming movements	0	0.0	1	1.8	1	0.8
Pelagic behaviour	0	0.0	1	1.8	1	0.8
Bioluminescence	0	0.0	1	1.8	1	0.8
Predation	6	9.5	16	28.6	22	18.5
Carnivory	0	0.0	1	1.8	1	0.8
Commensalism	7	11.1	33	58.9	40	33.6

Source: made by the authors.

Furthermore, most of the students (99.3%) from both elementary school and university correctly identified creatures from the TCGs that were inspired by sharks or rays (Figure 2), showing that they were capable to recognize the TCG creatures as real elasmobranchs-inspired, including morphological and ecological traits of these animals (Figures 3 and 4).

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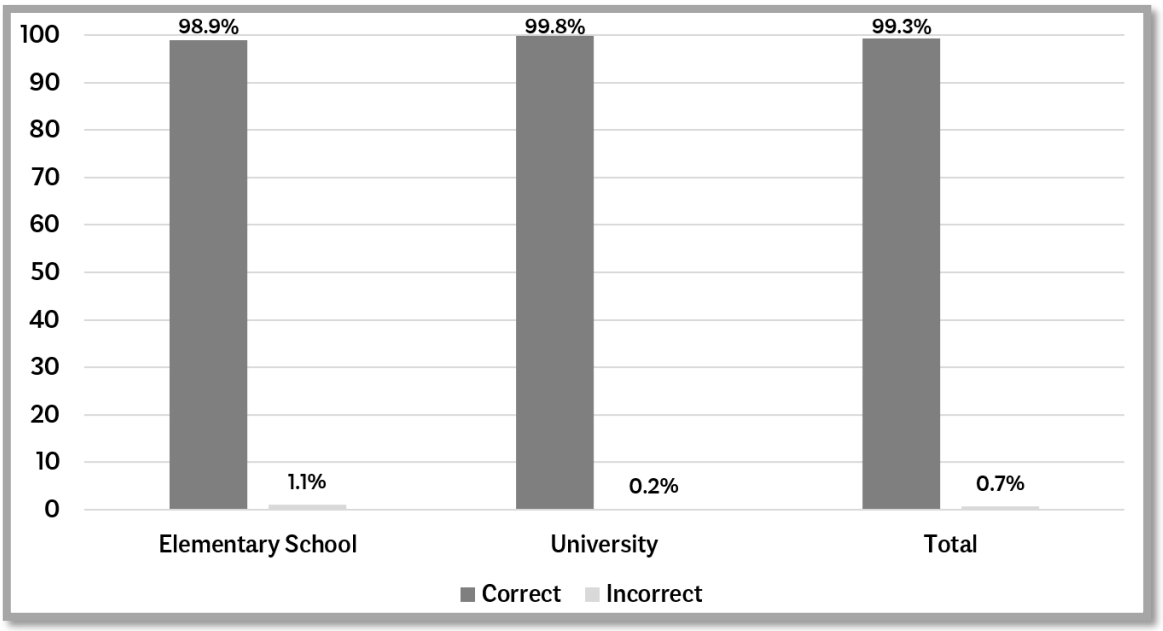
Figure 2: Percentage of correct and incorrect answers given by Elementary School and University students when asked which cards were sharks-inspired and which were based on rays.



Source: made by the authors.

Students appreciated the activity (98.3% said they liked it), especially due to its ludic features (76.9%, Figure 5). This was evidenced in answers such as “it was fun and different from the chalkboard routine”, “because it made the students interact”, “because it took away my boredom and I thought the activity was very amusing”, and “I believe that more ludic dynamics in the classroom can be efficiently helpful in learning process”.

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Figure 3: Cards inspired by sharks.

Source: photographed and made by the authors. The numbers indicate some characteristics answered by the students, 1: nostrils; 2: commensalism; 3: live in water; 4: heterocercal tail; 5: elongated rostrum with modified placoid scales of sawfish; 6: triangular teeth; 7: lateral gills slits; 8: bioluminescence; 9: mouth; 10: predation; 11: dark colour on dorsal region and lighter on ventral region; 12: lateral eyes; 13: ampullae of Lorenzini; 14: T-shaped head of hammerhead shark; 15: pointed fins; 16: live in sea; 17: dorsal fins; 18: pectoral fins; 19: pelvic fins; 20: anal fins; 21: tooth series; 22: skeleton. The cards were published by Konami (*Yu-Gi-Oh!*, www.konami.com), The Pokémon Company (*Pokémon*, www.pokemon.com), and Bushiroad (*Cardfight! Vanguard*, www.bushiroad.com).

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Figure 4: Cards inspired by rays.

Source: photographed and made by the authors. The numbers indicate some characteristics answered by the students, 1: ventral gills slits; 2: commensalism; 3: live in water; 4: cephalic lobes; 5: large pectoral fins; 6: sting; 7: ventral mouth; 8: electric shock as a defensive mechanism; 9: whip-shaped tail; 10: eyes; 11: dark colour on dorsal region and lighter on ventral region; 12: swimming movements; 13: flat body; 14: cartilaginous skeleton. The cards were published by Konami (*Yu-Gi-Oh!*, www.konami.com), The Pokémon Company (*Pokémon*, www.pokemon.com), Wizards of the Coast (*Magic: The Gathering*, www.wizards.com), and Bandai (*Digimon*, www.bandai.com).

Moreover, most students (97.6%) thought that activities using elements of pop culture are interesting for the teaching-learning process of science and biology, mainly because it is a way to facilitate it (71.5%, Figure 6).

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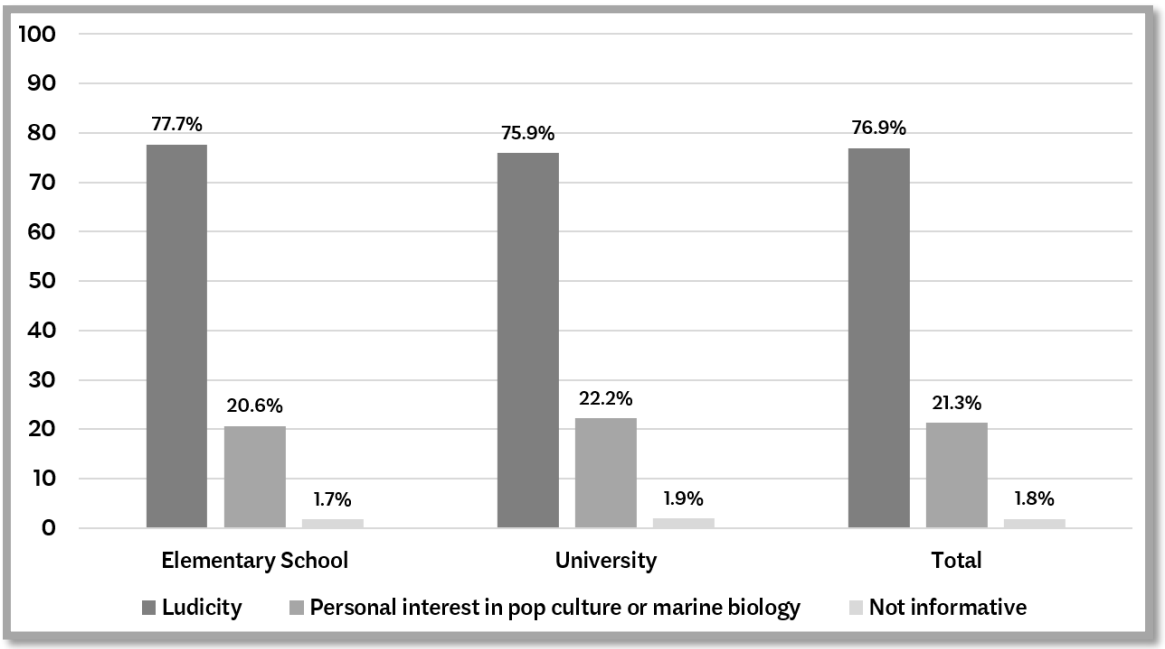
Figure 5: Percentage of answers given by students when asked why they liked the activity.



Source: made by the authors. "Ludicity" category = interaction, novelty, games, fun and learning. "Personal interest in pop culture or marine biology" = students' interest in TCG, movies and cartoons characters or/and Science contents such as fishes and marine biology topics in general. "Not informative" = blank answers.

Both elementary school and university students were very participative during the proposed activity. Although the questionnaires were individually answered, the working groups were essential for students to interact and discuss important topics about morphology, ecology, ethology, and conservation of elasmobranchs. What became evident is that the use of TCG cards in a teaching activity created a closer connection between students and elasmobranchs in an effective and affective way.

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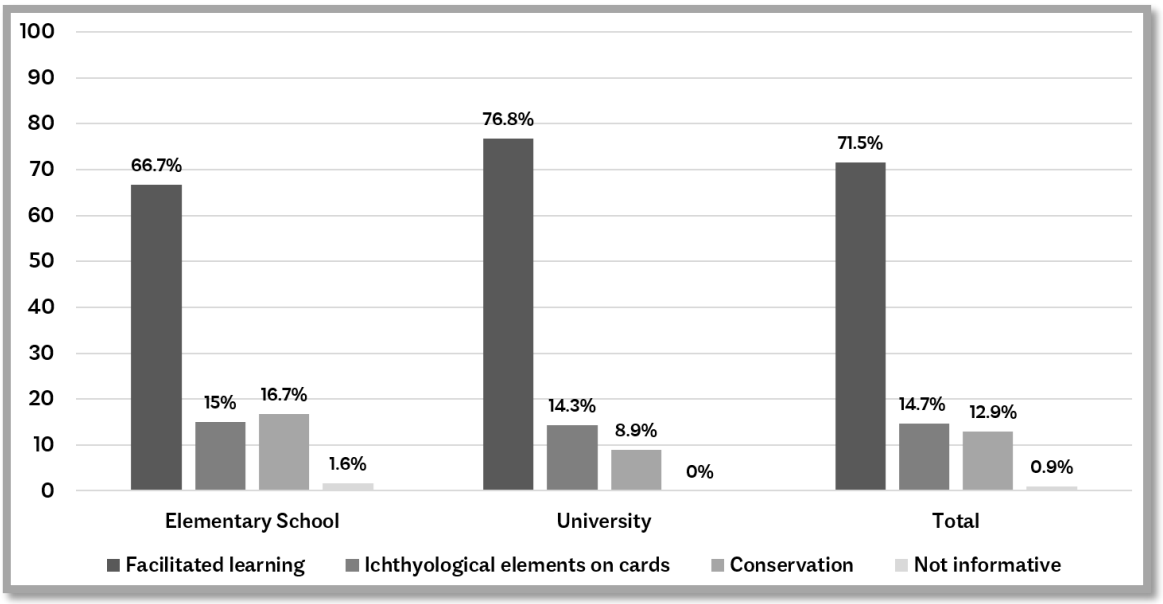
Figure 6: Percentage of answers given by students when asked why they thought that activities using pop culture are interesting in classroom.



Source: made by the authors. "Facilitated learning" = fun, easy and effective way of learning. "Ichthyological elements on cards" = how TCG cards accurately feature elasmobranchs' characteristics and how this can be useful in teaching-learning processes on science themes as fishes and Chondrichthyes. "Conservation" = students' shift on thinking about sharks and rays and how activities like this can raise discussions about the need to conserve these animals. "Not informative" = blank answers.

4 Discussion: The Right Move

The results showed that the students were able to identify several characteristics of sharks and rays in the fictional creatures of TCGs. Undergraduate students listed more characteristics than elementary school students, often giving more specific answers. For example, university students answered all types of fins (pectoral, pelvic, anal, caudal, and dorsal), while those in elementary school only stated "fins". This might be related to greater scientific maturity of undergraduate students and not to the interest and level of engagement in the activity. In addition, in the university lectures, the scientific approach was deeper, with more use of biologic terms like "pelagic behaviour" and "cranial kinesis", for example. No unrealistic features such as arms, purple colour or robotic/metallic body were mentioned in the answers, suggesting that students were able to discern biological features and fictional features in the TCGs creatures.

The number of biological characteristics mentioned by the students after the activity suggests a great potential of the elements of pop culture as a teaching tool. Although this study has focused on elasmobranchs, TCG cards feature all kinds of living beings. Carnall (2018), for

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example, identified 21 *Magic: The Gathering* cards inspired by cephalopods, and Joaquim Junior *et al*. (2019) identified 159 *Yu-Gi-Oh!* cards inspired by insects. The use of TCGs in classrooms has also been discussed in Gee (2018), which concluded that *Yu-Gi-Oh!* cards are a good support tool in child literacy. Vasquez (2003) also studied the potential of TCG (this time *Pokémon*) in process of learning and literacy and highlighted that "popular culture texts such as *Pokémon* cards and games are the kinds of materials that many kids read, have access to, and participate with as literate beings in the new millennium" (p. 124). Likewise, Hayes and Gee (2010) argued that

> "card games (convergent media as well, since they involve card games, books, televisions shows, video games, movies, and websites) like *Pokémon*, *Yu-Gi-Oh*, and *Magic: The Gathering* involve hundreds or thousands of characters and cards, each of which is associated with myriads of information" (p. 185).

The cards' information (name, illustration, what they do, and in which situation they can be used), may stimulate them to learn specific contents, including themes in Biology by creating a similar motivation for students (LENARCIC; MACKAY-SCOLLAY, 2005; TURKAY *et al*., 2012).

In addition to the fact that the cards are useful in ludic activities addressing themes related to morphology and ecology of elasmobranchs, the use of TCG cards as a teaching tool is capable of narrowing the gap between students, science, and environmental awareness, promoting conservation. This is the right move: use pop culture elements like TCG cards to create affection between students and elasmobranchs, thus we can engage students thinking about conservation issues. The possibility and importance of this move were previously emphasized by the work of Balmford *et al*. (2002), who used *Pokémon* TCG in the classrooms. The authors asked primary school students to identify ten types of British wildlife from flashcards and ten *Pokémon* creatures from TCG cards. The study concluded that students were more capable of recognizing *Pokémon* than real organisms. This result suggests that young children have the skills to recognize and catalogue organisms, showing that TCG cards can help teachers to establish links between children, nature, and conservation. Similarly, Callahan *et al*. (2019) tested Phylo game, a *Pokémon*-inspired TCG that presents various cards featuring flora and fauna, with graduate and undergraduate students and concluded that Phylo has potential for enhancing ecological literacy, motivation environmental citizenship, and contribute to more affinity between people and the natural world.

If the TCG cards contain several characters and if the students can recognize such characters as real animals, the cards can be an important tool to connect the audience with these animals, especially when the characters are portrayed in a rather charismatic way. Some sharks and rays can be considered flagship species (JEPSON; BARUA, 2015; STEVENS *et al*., 2018), which are species selected to act as symbols for a specific habitat or environmental cause, often gaining a lot of public attention, scientific studies and conservation support (HAMMERSCHLAG; GALLAGHER, 2017). Thus, these animals are charismatic in a conservationist sense because they have great popular appeal and strong symbolic value, often

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being the face of environmental campaigns and management strategies (MCCLENACHAN *et al*., 2012; ALBERT *et al*., 2018) and attracting huge amount of attention and resources in international conservation efforts (KRAUSE; ROBINSON, 2017). However, in common sense, elasmobranchs, especially sharks, are non-charismatic fishes and most of the time tied to feelings like fear and panic, due to shark attacks and misrepresentations in media as in the film *Jaws* (NEFF, 2012). Through TCG cards, it is possible to deconstruct the misconceptions around these animals and to create affection among children, adolescents, and young adults towards the elasmobranchs, discussing the importance of these species to ecosystems and, thus, helping in the cause of conservation. In this study, this became clear in answers such as "the activity was very interesting and I don't want to kill sharks and rays anymore" and "I found it very interesting to know more about elasmobranchs, and I learned that it is a bad thing to kill them".

The role of mass pop culture in the development of a conservationist mentality in children and young people has been widely evaluated in several works that seek to understand the benefits of films, games, and animations that portray animals, which are often threatened. Sandbrook *et al*. (2015) argued that some of the biodiversity conservation objectives are to promote learning and changes in attitudes related to nature. In this sense, media that portrays positive images about species that are not affectively charismatic to the general public, such as sharks, are important tools for conservation (YONG *et al*., 2011).

Recently, popular culture has raised public awareness about the varied dimension of biological diversity, making people understand the wide variety of species and environments and, therefore, helping preservation causes. For instance, *Pokémon* in its various representations, "encourages reflection on the ways in which we represent, engage and contain nature" (BAINBRIDGE, 2014, p. 409) and exposes the public to concepts of natural history as habitat and abundance of individuals (Dorward *et al*., 2017).

5 Final Considerations: The Game Continues

In this study, elements of popular culture were used to produce an interactive ludic activity to teach students, eliciting their creativity and imagination, and helping them to deconstruct stereotypes about Elasmobranchii species. This research provides relevant data regarding the potential of popular culture media for the development of conservation pedagogical strategies in science education at elementary and university levels. The teaching activity applied in this study was capable of fostering interest in students that showed positive attitudes concerning the environment and this group of animals, especially sharks. Movie narratives about sharks are known to have influenced policy regarding these animals (NEFF, 2015). Deconstructing misconceptions of sharks, usually portrayed in the mainstream media and movies as man-eater monsters, is an important step towards a greater care about these animals on the general population and, consequently, their conservation.

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The use of media and pop culture elements represented here on TCG cards showed to be an effective science pedagogical activity to promote a greater bond and affection between students and elasmobranchs. These types of activities can lead to changes in the current common sense that assume sharks and rays as a threat to humans and that create challenges for their conservation This study shows the potential of using media and pop culture to promote affection towards certain species and conservation. However, even though TCG cards served as a good strategy in the contexts studied, further investigations are needed to understand how to better take advantage of the increasing presence of pop culture and media on students' daily lives, especially on the internet and social medias, and how they can be used to develop new pedagogic activities and strategies that can be used in different contexts and for different species.

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Appendix: List of 80 cards used in the classroom activity. The cards were published by Konami (*Yu-Gi-Oh!*, www.konami.com), The Pokémon Company (*Pokémon*, www.pokemon.com), Wizards of the Coast (*Magic: The Gathering*, www.wizards.com), Bushiroad (*Cardfight! Vanguard*, www.bushiroad.com), and Bandai (*Digimon*, www.bandai.com).

Card name	Trading Card Game	Card number
Double Fin Shark	*Yu-Gi-Oh!*	DUSA-EN001
Depth Shark	*Yu-Gi-Oh!*	DUSA-EN003
Saber Shark	*Yu-Gi-Oh!*	DUSA-EN004
Deepsea Shark	*Yu-Gi-Oh!*	PMT-P038
Spear Shark	*Yu-Gi-Oh!*	CBLZ-EN009
Double Shark	*Yu-Gi-Oh!*	CBLZ-EN010
Xyz Remora	*Yu-Gi-Oh!*	CBLZ-EN011
Hyper Ancient Shark Megalodon	*Yu-Gi-Oh!*	CBLZ-EN012
Wind-Up Shark	*Yu-Gi-Oh!*	CBLZ-ENSE1
Mermaid Shark	*Yu-Gi-Oh!*	PRIO-EN005
Gazer Shark	*Yu-Gi-Oh!*	PRIO-EN006
Cyber Shark	*Yu-Gi-Oh!*	AP01-EN016
Man-Eating Black Shark	*Yu-Gi-Oh!*	AP06-EN021
Shark Caesar	*Yu-Gi-Oh!*	JOTL-EN049
Sharkraken	*Yu-Gi-Oh!*	LTGY-EN007
Panther Shark	*Yu-Gi-Oh!*	LTGY-EN010
Eagle Shark	*Yu-Gi-Oh!*	LTGY-EN011
Mecha Phantom Beast Stealthray	*Yu-Gi-Oh!*	LTGY-EN024
Shark Fortress	*Yu-Gi-Oh!*	LTGY-EN048
Great White	*Yu-Gi-Oh!*	SDY-011
Misairuzame	*Yu-Gi-Oh!*	LDB-P111
Shark Cruiser	*Yu-Gi-Oh!*	ANPR-EN028
Scrap Shark	*Yu-Gi-Oh!*	STOR-EN030
Big Jaws	*Yu-Gi-Oh!*	SP13-EN006
Submersible Carrier Aero Shark	*Yu-Gi-Oh!*	SP13-EN024
Hammer Shark	*Yu-Gi-Oh!*	SP14-EN013
The Legendary Fisherman	*Yu-Gi-Oh!*	SP17-EN001
The Legendary Fisherman III	*Yu-Gi-Oh!*	SP17-EN028
Subsurface Stage Divers	*Yu-Gi-Oh!*	SOFU-EN080
Cat Shark	*Yu-Gi-Oh!*	PGL2-EN016

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Metabo-Shark	*Yu-Gi-Oh!*	BP03-EN068
Friller Rabca	*Yu-Gi-Oh!*	BP03-EN090
Corroding Shark	*Yu-Gi-Oh!*	TP1-S020
Flyfang	*Yu-Gi-Oh!*	GENF-EN019
Skystarray	*Yu-Gi-Oh!*	GENF-EN020
Oh Fish!	*Yu-Gi-Oh!*	GENF-EN069
Gishki Abyss	*Yu-Gi-Oh!*	HA05-EN031
Phantom Dragonray Bronto	*Yu-Gi-Oh!*	TAEV-EN087
Nimble Manta	*Yu-Gi-Oh!*	GAOV-EN097
Creeping Doom Manta	*Yu-Gi-Oh!*	RDS-EN025
Number 42: Galaxy Tomhawk	*Yu-Gi-Oh!*	MP15-EN055
Painful Decision	*Yu-Gi-Oh!*	MP16-EN151
Sea Stealth Attack	*Yu-Gi-Oh!*	LEDU-EN018
Abyss Stungray	*Yu-Gi-Oh!*	CROS-EN077
White Stingray	*Yu-Gi-Oh!*	CYHO-EN096
Sharktocrab	*Magic: The Gathering*	RNA 206/259
Hammerhead Shark	*Magic: The Gathering*	TPR 52/269
Giant Shark	*Magic: The Gathering*	DRK 29/119
Manta Ray	*Magic: The Gathering*	WTH 42/167
Cloud Manta	*Magic: The Gathering*	BFZ 71/274
Riftwing Cloudskate	*Magic: The Gathering*	JVC 15/62
Skyreach Manta	*Magic: The Gathering*	5DN 152/165
Cloudskate	*Magic: The Gathering*	NEM 29/143
Wormfang Manta	*Magic: The Gathering*	JUD 58/143
Trygon Predator	*Magic: The Gathering*	DIS 133/180
Battering Krasis	*Magic: The Gathering*	DGM 41/156
Deepglow Skate	*Magic: The Gathering*	CM2 39/312
Manta Riders	*Magic: The Gathering*	TMP 74/350
Half-Shark, Haf-	*Magic: The Gathering*	UST 35/216
Riptide Chimera	*Magic: The Gathering*	JOU 48/165
Sharpedo	*Pokémon*	TM 30/102
Sharpedo	*Pokémon*	PLS 33/135
Sharpedo EX	*Pokémon*	PRC 152/160
M Sharpedo EX	*Pokémon*	XY200
Sharpedo Spirit Link	*Pokémon*	XY 201
Mantyke	*Pokémon*	DP 55/130
Mantine	*Pokémon*	RR 45/109

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Mantine	*Pokémon*	HS 45/123
Mantine	*Pokémon*	STS 27/114
Mantine	*Pokémon*	DF 20/101
Gabite	*Pokémon*	MT 48/123
Gible	*Pokémon*	BKP 68/122
Garchomp	*Pokémon*	BKP 70/122
Spiral Master	*Cardfight! Vanguard*	BT03/054EN
God-Eating Zombie Shark	*Cardfight! Vanguard*	BT06/061EN
Mako Shark Soldier of the Blue Storm Fleet	*Cardfight! Vanguard*	BT16/141EN
Blue Wave Soldier, Twinhead Shark	*Cardfight! Vanguard*	G-BT13/110EN
Spicule Shark	*Cardfight! Vanguard*	G-TD15/015EN
Invite Roaring, Inray	*Cardfight! Vanguard*	G-RC01/044EN
Mantaraymon	*Digimon*	BO-195

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