Review

A Critical Review of Studies on Coopetition in Educational Settings

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Abstract: The benefits and limitations of utilizing collaborative and competitive activities within and between groups to facilitate learning are well known. Typically, these two concepts are viewed as mutually exclusive approaches, where one is favored over the other in the classroom. However, utilizing an approach that takes advantage of the strengths of both while minimizing each one's weaknesses, could greatly enhance students' learning. This approach is called coopetition. Because of the dominance of collaboration and competition, the number of studies investigating coopetition in learning environments is rather limited. Therefore, this article reviews the extant studies using a coopetitive approach to provide a fuller understanding of this concept. Altogether, 33 articles were retrieved and analyzed using a grounded constant-comparative approach. As a result of the analysis, three categories of research topics emerged: (a) organization of coopetition, including zero-sum coopetition and social comparison coopetition, (b) medium and coopetition, including coopetition conducted in conventional face-to-face settings and computer-mediated settings, and (c) application of coopetition in education, which covers multiple areas such as cognitive, affective, and social domains, as well as educational management. The review discusses each category in detail, highlighting implications for future educational research and practice.

Keywords: coopetition; collaboration; competition; education

1. Introduction

Debates on collaboration and competition in education have spanned several decades, yet conclusive evidence supporting one over the other remains elusive [1,2]. Collaboration, which broadly refers to situations where group members work together to learn or attempt to learn something [3], can help hone students' communication and leadership skills, promoting the development of creativity and knowledge sharing [4,5], but it is often beset with such problems as the consistent presence of free-riders, imbalanced levels of commitment and responsibility, and compromised group effectiveness [6,7]. In contrast, competition, or scenarios where players compete against each other for a limited number of desired outcomes, can greatly stimulate learners' motivation, and enhance their engagement and ingenuity [8–10]. However, it is often criticized for disrupting group process and causing stress among learners [11,12].

Though collaboration and competition have each enjoyed success in education, utilizing an approach that integrates the advantages of both, while minimizing their limitations [13], may be more effective at advancing students' learning. This approach is called coopetition.

Coopetition is a blend word from competition and cooperation/collaboration and refers to the simultaneity of competitive and collaborative relationships between actors within and between groups, who engage in deliberate goal-seeking actions to optimize their gains [14]. It is an emergent construct initially appearing in strategic management research and was introduced to business research by Brandenburger and Nalebuff [15]. Since its inception, it has enjoyed increasing scientific interest in varied areas, such as biology and

ecology [16–19], and has recently received more attention in the field of education [20,21]. However, because the educational field has yet to fully embrace this approach, the amount of literature available is rather limited.

A point of departure to explain how coopetition integrates the benefits of competition and collaboration while limiting their drawbacks can be taken from its most dominant type: intergroup competition–intragroup collaboration where collaboration and competition are directed to different players. Maintaining effective collaboration can be challenging, as there is often an incentive for group members to free-ride on the efforts of others, which can ultimately lead to the breakdown of collaboration altogether. These costs of sustaining effective collaboration can be diminished when there is competition at a higher level of organizational hierarchy. For instance, at the intergroup level, intergroup competition has been shown to strengthen the moral emotions of anger and guilt associated with group members violating collaborative norms [22], promote group cohesion [23], help eliminate inefficiency of group members' work almost completely [24], and enhance in-group members' motivation for excellence [25], which eventually leads to improved group collaboration. This, together with collaboration among players within the group, enables all members within the coopetitive network to gain benefits they could not have achieved alone, including knowledge creation, important research breakthroughs, and collaborative innovation [26–29], which consequently enhances their competitive advantages.

Despite these benefits, limited research on coopetition has been conducted in the educational field, where primary attention has been given to either collaborative learning or competitive learning. Given the importance of coopetition in other fields and its potential contribution to advance education, this paper reviews previous studies on coopetition in the educational field with the aim of delineating how coopetition has been carried out and extracting implications for future educational research on collaborative learning and coopetition. However, because few articles have explicitly aimed to investigate coopetition in learning, it is possible to analyze studies that have utilized the approach without using the term "coopetition" to describe it. Identifying and analyzing these articles for how coopetition has been utilized in the classroom should contribute to our understanding of the coopetition construct in the educational field. To that end, this review paper aims to answer the following questions:

(a) How were coopetition-related studies implemented in the educational field?

(b) What are the implications of coopetition and suggestions for future educational practice and research?

2. Theoretical Foundation and Research Hypotheses

2.1. Criteria of Coopetition

Making a comparison between collaboration and competition cannot be considered as coopetition. Identification of coopetition-related studies in the educational field will be primarily based on the existing research in the business area. The business research has examined coopetition at different levels: individual level [30,31], intra-organizational level [32,33], inter-organizational level [34–37], and network level [38]. The multi-level nature of coopetition illustrates that it is a complex construct with multiple variations for use in varied context. Based on these categorizations, which are not decisive and are still evolving, the following scenarios will be considered as coopetition:

Intragroup collaboration–intergroup competition: Players collaborate within a group and compete with the out-groups simultaneously. In this case, collaboration and competition are directed to different players. Intergroup competition is considered to be constructive to intragroup collaboration and can greatly activate players' motivation [13].

Intergroup competition–intergroup collaboration: Two or more competitor groups collaborate with one another in some areas, while competing against one another and against other groups in other areas to maximize their outcomes. In this case, collaboration and competition are primarily directed to the same players. This type of coopetition is very volatile and is often associated with considerable tensions [39,40].

Intragroup collaboration–intragroup competition: People within a group collaborate and compete with one another at the same time. This type of coopetition is focused on the individual level and is usually directed to the same players. Strong tensions are also experienced in this type of coopetition [14].

2.2. Selection of Studies

The current study aimed to specifically review literature that integrates collaboration and competition in educational settings to enhance student learning, rather than focusing solely on studies that utilized either collaboration or competition strategies in isolation.

Twenty-seven online databases were used for searching the literature, including Academic Search Premier, British Education Index, Business Source Premier, ERIC, Education Source, PsycINFO, PsycCRITIQUES, PsycTESTS, GreenFILE, Library Literature & Information Science Full Text (H.W.Wilson), Google Scholar, etc. The literature was searched by using combinations of the following keywords: "coopetition", "competition", "compet*", "collaborat*", "cooperat*", "computer or internet or online or web", "learn*", "study*", and "team or group". The search yielded considerable numbers of studies on either collaboration or competition separately. However, few studies were identified as investigating both collaboration and competition in the educational field. After multiple rounds of searching, 19 articles were singled out based on the following inclusion criteria: (a) studies are conducted in the educational domain, while those in the fields of conflict management and business are not considered; (b) they fit the criteria that help identify studies on coopetition as listed above; (c) they are peer-reviewed journal papers, conference articles, dissertations, or book chapters. Based on the inclusion criteria, another 14 articles were identified by tracing references of these 19 studies. In the end, a total of 33 articles were selected for the final review.

In this review, "collaboration" is used interchangeably with "cooperation" since they have similar meanings and are used interchangeably in many educational studies [20,23,41,42] and business research [26,40,43].

3. Methodology

A critical review approach was utilized in this study as it aims for a critical evaluation of a piece of literature, which involves identifying its strengths and weaknesses, assessing its credibility and relevance, and providing a balanced and informed perspective on its significance. In contrast, a systematic review provides a comprehensive summary of the available evidence on a particular topic, which can inform policy and practice decisions. While both approaches are often used in review studies, a critical review goes beyond summarizing the evidence and includes a critique and reflection of the topic under study. Additionally, a critical review often adopts emerging coding strategies, while a systematic one follows a pre-defined coding protocol.

A grounded constant-comparative approach was used to analyze the selected articles [44]. Using this approach is beneficial when the researcher aims to identify emerging topics from the literature in a bottom-up manner. The analysis consisted of multiple rounds of manual coding. Hard copies were used to mark up the emerging categories. The first few articles were typically analyzed to provide tentative categories. The process of generating tentative categories began with an initial review of the articles, during which the researchers took notes, highlighted key phrases or ideas, and jotted down initial impressions of the content. These notes and impressions were then used to develop preliminary codes or categories that captured the essence of the data.

Once the tentative categories were established, the researcher could begin the process of applying them to subsequent articles. Each new article was carefully scrutinized to determine which tentative categories it belonged to, and whether it introduced new themes or concepts that may have required the creation of additional categories. By continually revising and refining the categories, the researchers were able to identify and describe the underlying patterns and themes that were present in the data, and develop a comprehensive

understanding of the research question at hand. Following this process, the 33 articles were analyzed and categorized.

4. Results

Overall, three main categories of research topics emerged as a result of the analysis: (a) Organization of coopetition, (b) Medium and coopetition, and (c) Application of coopetition in education. These categories will be discussed in relation to their importance to the educational field.

4.1. Organization of Coopetition

Because coopetition involves features of collaboration and competition, the analysis looked at both constructs independently and together. The analysis revealed that collaboration was operationalized similarly across the reviewed studies, indicating that the researchers maintained a consistent interpretation of collaborative learning, that of involving two or more people learning or attempting to learn something together through face-to-face and computer-supported mediums [3].

Although competition has been examined and discussed extensively in previous studies, few researchers have sought to clarify its nature. The concept of competition has been assumed to be mostly the same across different studies. Nevertheless, the review of extant studies found that competition is not a unanimously agreed-upon construct and has been operationally defined in remarkably different ways. Three types of competition emerged from the analysis: (a) zero-sum competition where competition for limited desired outcomes results in winners getting them at the expense of losers [45], (b) social-comparison competition where actors can compete without having to destroy their oppositions [15], and (c) unstructured competition. The first two types of competition can be further divided into two subtypes: (a) intragroup competition and (b) intergroup competition, where player compete with members of their own group and against members of opposing groups, respectively. These three types of competition, along with collaboration, can be used to form a framework into which extant studies on coopetition could be categorized: (a) zero-sum coopetition, (b) social comparison coopetition, and (c) unstructured coopetition (see Table 1).

Table 1. Framework of Coopetition Organization and Distribution of Relevant Studies.

Organization of Coopetition	Percentage		
	Intergroup Competition	**Within-Group Competition**	**Total**
Zero-sum coopetition [1,2,12,20,23,46–55]	15	0	15
Social comparison coopetition [4,25,41,42,56–64]	9	4	13
Unstructured coopetition [65,66]			2
Unclassified others [21,67,68]			3
Total			33

4.1.1. Zero-Sum Coopetition

Zero-sum competition originates from the zero-sum game in game theory. In a zero-sum game situation, one party's success is always countered by another party's loss [15,45]. In the zero-sum game, each player chooses his/her best strategy to maximize his/her chance to win [45]. Rewards (e.g., financial prize, certificate, etc.) are given to a limited number of people on the basis of how they perform in comparison with others doing the same work. Though pitting learners against each other may be frowned upon in certain

educational contexts, winning and losing can both result in substantial learning [69]. Zero-sum game is so common in education that the majority of current educational systems are based on the zero-sum competition for scholarship and admission to top schools [70].

Among the 33 studies reviewed, 15 were identified as taking the form of zero-sum coopetition. All 15 studies were organized by combining intergroup competition with intragroup collaboration [20,48].

In intergroup competition coupled with intragroup collaboration, members within the same group collaborate with one another while competing against other groups for a prize or honorable certificate. Most often, it is all groups in one class or project that compete to be the best ones. The research findings generally indicated that this type of instructional strategy enhanced students' motivation and engagement, as well as improved students' learning performance.

For instance, Wang explored the effectiveness of competitive Student Team Achievement Division (STAD), non-competitive STAD, and traditional learning on chemistry learning and learning perceptions [23]. The STAD learning model involved students working together to master the assigned material in heterogeneous teams of four. The competitive STAD condition involved different teams competing with one another while the members within the same team collaborated to finish the task. Performance rewards were given to winning groups. Participants in the non-competitive STAD condition only collaborated with each other, and no performance reward was given. The competitive STAD group ($M = 82.24$, $SE = 15.35$) scored significantly higher than the non-competitive STAD group ($M = 68.62$, $SE = 17.78$) in the final examination, $F = 9.913$, $p = 0.000 < 0.05$. Qualitative analyses revealed that students in the competitive STAD experienced more academic support from their partners and positive interdependence than those in non-competitive STAD groups, who failed because of insufficient individual accountability, apathy, and lassitude.

Nevertheless, only one study proved otherwise. Yu examined the effects of embedding competition in computer-assisted cooperative learning situations on student cognitive, affective, and social outcomes using self-report questionnaires [12]. One hundred and ninety-two students from one primary school were randomly assigned to two treatments: collaboration/no competition condition and collaboration/ competition condition. To further strengthen the sense of competition, the researchers put up posters with words such as "Be the best" in the class. Students in the cooperation/no competition condition were found to have better attitudes toward science ($F = 8.13$, $p = 0.0049$), better perceptions of their own dyad ($F = 4.75$, $p = 0.0338$), of other dyads ($F = 7.40$, $p = 0.0072$), of the communication process within their own dyad ($F = 4.45$, $p = 0.0362$), and of the communication process among the dyads ($F = 5.14$, $p = 0.0245$) than those in the coopetition/competition condition. Nevertheless, no significant differences were identified in students' academic achievements.

Coopetition designs that combine intragroup collaboration and intergroup competition mostly demonstrated great benefits in contributing to students' cognitive, social, and affective outcomes. Regarding why Yu's study showed negative attitudinal outcomes, it may be due to the intensified sense of competition created by the author who deliberately put up posters of competition in the class [12]. In addition, the participants were primary school students who were easily swayed by the external environment and strengthened competition may have caused negative impressions on the students.

Following this, although coopetition possesses potential for education, what matters for the effectiveness of education still lies in its design. Competition should not be intensified, as the mere presence of a competitor will greatly influence players' performance. Carefully crafted competition at the group level can avoid the negative pressure caused by competition on individual students, while being able to increase their motivational levels [13]. Tauer and Harackiewicz argue that collaboration induces participants to approach the learning activities with more interpersonal enthusiasm, while competition motivates students to value competence and perceive greater challenges [54]. Intergroup competition with intragroup collaboration helps students manage to do both.

4.1.2. Social-Comparison Coopetition

In this type of research, competition is structured as a comparison or peer-reference among participants. Social comparison coopetition is based on Bandura's social learning theory that argues that human behaviors are not innate as such [71], but rather are learnt both through one's own experiences as well as through the modeling of others in the social world. By observing and modeling others, individuals develop knowledge to inform their future actions and performance.

In contrast to zero-sum coopetition, winning is not an important aspect of the learning situation and in some instances, all groups can be winners [63]. In social-comparison coopetition, the competing process is emphasized over the outcome of the competition. During coopetition, groups can learn from their own and their competitors' progress and mistakes [4,25]. Sometimes there is not even any form of prize given to the winner. To be perceived as a winner, one party does not have to defeat another. The process of constant comparison and peer-reference through participants displaying their learning products/performance to other participants is emphasized. Every player and group is aware of their own performance and that of others. By observing others' progress, one reflects on his/her own and compares his/her work with those of others. The existence or exhibition of other participants' work and progress provides a standard against which one's own performance can be evaluated. This modeled behavior is able to prompt self-motivation [71], and after several cycles of comparison and reference, learners are able to improve and innovate ways of learning. The comparative process can easily result in a sense of competition, which is healthy and may even give rise to feelings of pride and personal satisfaction [57].

Among the 33 selected studies, 13 were identified as using social-comparison coopetition. Nine out of the 13 studies took the form of intergroup competition coupled with intragroup collaboration [42,59], while the remaining four studies adopted the form of intragroup competition coupled with intragroup collaboration [41,57,58,60]. This is in stark contrast with the studies using zero-sum coopetition in which all studies took the form of intergroup competition coupled with intragroup collaboration.

(a) Intergroup competition coupled with intragroup collaboration. Intergroup competition of the social comparison type is quite moderate compared to the zero-sum type. The nine studies generally demonstrated that social-comparison coopetition strengthened group collaboration, promoted learning motivation and engagement, made the learning experience enjoyable, and enhanced student academic outcomes.

For instance, Ke and Grabowski examined the effects of different modes of game-playing (i.e., Teams-Games-Tournament (TGT) cooperative game-playing, interpersonal competitive game-playing, and no game-playing) on students' mathematical exam performance and attitudes [59]. TGT is actually a competitive design for collaborative team work. In the study, students receiving the TGT game-playing treatment were randomly assigned into groups of four. They firstly collaborated by discussing questions and finding solutions to mathematical problems. Then, different teams competed against one another to earn scores. At the end of every two gaming sessions, the individual and team scores were ranked and listed in a newsletter, which was disclosed to the whole class. In doing so, students were constantly aware of their own and others' performance, which motivated them to reflect on their progress and improve their performance in the next step. Although pair-wise comparison did not find significant differences for math performance between TGT ($M = 61.2$) and interpersonal competitive game-playing ($M = 59.9$), both scored significantly higher than the control group ($M = 55.3$; $p_{TGT} = 0.009$; $p_{inter} = 0.050$). Pair-wise comparison of attitudes revealed that TGT collaborative and competitive game-playing ($M = 79.1$) enhanced significantly more positive math attitudes than the interpersonal competition ($M = 74.6$, $p < 0.05$) and control group ($M = 72.3$, $p < 0.0001$). In this case, no prize was even set in the TGT coopetition; thus, no high-stake interest was tied to the coopetition. Although competition was set at the intergroup level, it did not damage the group's collaborative learning process by causing overwhelming anxiety and pressure in

students; instead, it added fun to the learning process. Different groups competing for higher scores were employed as a way to facilitate students' mathematical content learning, rather than to achieve scores per se. The disclosure of each student and group's score may enable all participants to compare their progress with others and motivate them to do better in future learning.

(b) Within-group competition coupled with within-group collaboration. Within-group competition refers to competition at the interpersonal level. Interpersonal competition was joined with interpersonal collaboration so as to enhance students' learning [41,61]. Findings from the reviewed studies generally suggested that this instructional design enhanced students' motivation and stimulated deep learning.

For instance, Pareto et al., examined how the collaborative and competitive affordances of the game may have affected students' math comprehension and attitudes towards mathematics [41]. Nineteen students from the third grade played the educational game in pairs once a week in math lessons for 7 weeks (the game-playing group) while another 19 students followed the regular curriculum with no game playing (the control group). The observation revealed that two students first collaborated to teach their respective Teaching Assistant (TA). However, later on, the same students collaborated to compete against their TA. So, collaboration was mixed with competition. Even when two students were competing, they also frequently talked about what they were doing and gave each other advice. The game-playing group performed significantly better in math comprehension than the control group, $F(1, 38) = 5.55$, $p < 0.05$. Qualitative analyses of students' reactions found that combining collaboration and competition can engage students more fully with the subject matter and promote their motivation and creativity.

Social-comparison coopetition produced no fewer positive outcomes than zero-sum coopetition even under conditions of no or few external incentives. Furthermore, within-group competition surprisingly did not produce the destructive and negative outcomes as suggested by previous studies, such as destroying the learning process, causing anxiety, and sabotaging creativity [11,72]. These may be explained by Stanne, Johnson, and Johnson's study about the moderators of competition [73]. The authors suggest that in order to make competition appropriate and constructive, its design has to meet four criteria: (a) winning is not heavily emphasized; (b) opponents are equally matched, which creates a challenging situation and provides each person with a reasonable chance to win; (c) the rules of competition are clear and straightforward, making for a fair competition; and (d) participants are able to evaluate their progress in relation to their opponents. Studies in social-comparison coopetition have in one way or another displayed these criteria. It is important to note that these four criteria were made for pure competitive situations without any relation to collaborative learning. However, they may be applicable to the coopetitive learning environment as well. Future research may seek to further test and modify these criteria.

4.1.3. Unstructured Coopetition

Unstructured coopetition refers to the vague procedural description of competition and collaboration. Among the 33 studies, two of them did not give a clear, operationalizable description of coopetition [65,66]. It was challenging to categorize these studies into either zero-sum coopetition or social-comparison coopetition, or even both. Although the coopetition design was unstructured, the findings of two studies, by and large, supported coopetition. For instance, Romanello briefly introduced several collaborative competition activities that his students joined, such as the NASA student involvement program, and the Junior Engineering Technical Society Test of Engineering Aptitude, Mathematics, and Science (JETS-TEAMS), where students competed with one another as groups [66]. However, no details were disclosed as to how students collaborated and competed. The author reported that students got the benefits of cooperative learning combined with the motivation of competition.

4.2. Medium and Coopetition

This review identified two types of medium through which coopetition was carried out: conventional face-to-face settings and computer-mediated settings. Conventional face-to-face settings refer to the traditional classroom, laboratory, and community where learning takes place through face-to-face interactions among students. In computer-mediated settings, studies are conducted through or around computer tools or platforms. Computer technologies in one way or another support or mediate collaborative and competitive processes. Following a discussion of both medium types independently, a comparison between the two approaches will be provided. Table 2 below documents the distribution of the studies.

Table 2. Distribution of Studies Conducted through Different Mediums.

Mediums	*n*
Conventional face-to-face settings [1,23,46–48,51–55,65]	11
Computer-mediated settings [2,4,12,20,25,41,42,49,50,56–64]	18
Unclassified others [21,66–68]	4
Total	33

4.2.1. Conventional Face-To-Face Settings

Overall, 10 studies were identified as being undertaken in conventional face-to-face settings. Among these studies, attention was primarily placed on applying both collaboration and competition to the traditional classroom setting, with such objectives as to stimulate students' learning interest and motivation, to promote service learning, and to enhance their academic performance [1,47].

In the study of Gibson et al. [1], for instance, the authors sought to redesign a traditional course about marketing activities in the fashion industry by incorporating intergroup competition into the collaborative learning setting where members within the same teams collaborated with one another. The fashion marketing course comprised three components. In the first two components, students formed into groups to solve the topics on fashion industry collaboratively. Different groups in the same class competed with one another to earn points. In the third component, top groups from different classes competed with each other. Through comparing overall semester grades between the traditional (n = 56) and redesigned course (n = 53), the authors found that the distribution of students from the traditional course in grade ranges of A, B, C, D, E, F was 66%, 28.6%, 3.6%, 1.8% and 0%, respectively; for the redesigned course it was 51%, 49%, 0%, 0%, and 0%, respectively. Students in the lower grade ranges had greater improvements. Findings from the qualitative analysis revealed that students were more enthusiastic about their learning projects than previous classes where there was no competition involved. The authors reported that the winning groups' projects showed a level of creativity, inventiveness, and professionalism that were not seen from traditional classes.

4.2.2. Computer-Mediated Settings

Seventeen studies were found to be performed through or around computer-mediated technologies. With the exception of Yu's study [12], 16 of them generally found coopetition useful and beneficial for student of different ages across many different disciplines, inclusive of mathematics, history, language learning, computer science, and engineering education. The combination of collaboration and competition provided students a great educational and real-world experience [13]. It stimulated students' learning motivation and interest, promoted their engagement and academic performance, and enhanced their creation and inventiveness [1,4,61].

Among the 17 studies, nine of them took the form of computer game-based learning [4,25,41,49,50,59,62–64]. For instance, Carpio Cañada et al. introduced the international Google AI Challenge into the Artificial Intelligence course where the Ants game was used [25]. The strategy of this game consisted of managing an ant colony in order to fight against other colonies for domination. Students were asked to work in groups and to develop different versions of their programs to test ideas and improve their intelligent agents in the game. The competition consisted of several phases, and before the final phase, student could revise and refine their programs constantly based on ideas and strategies shared by other contestants online. The users' rankings were continuously updated in the online platform. Two forms of collaboration were involved: (a) collaboration with teammates in the classroom; (b) collaboration with contestants online who may be their competitors from other places or countries and who published ingenious ideas and strategies in the online platform to solve the problems they met. Statistical findings from the five-point scale indicated that students experienced a significant knowledge accruement (M_{before} = 1.89, SD_{before} = 0.32; M_{after} = 3.42, SD_{after} = 0.45; $p < 0.001$) and enhanced interest/motivation (M_{before} = 3.10, SD_{before} = 0.40; M_{after} = 4.05, SD_{after} = 0.35; $p < 0.003$). Compared to the previous two years when there were no such instructional designs, the fourth-year students of the computer science degree who joined the study showed a significant increase in average academic scores on a 10-point scale from 5.45 and 4.42 to 7.16. The study also reported increased teamwork, information sharing, and improved perception on courses as a result of the methodology.

4.2.3. A Comparison between the Conventional Face-To-Face and Computer-Mediated Approach

Among the 17 studies on coopetition learning in computer-mediated settings, three of them compared the effect of computer-mediated pedagogy with that of a conventional approach not using technologies [41,49,59]. Generally, the findings suggested that computer-mediated pedagogy outperformed the conventional approach in terms of enhancing academic performance, sustaining engagement, and improving interaction. For example, Hung et al. developed a Wireless Crossword Fan-Tan game (WiCFG) to support collaborative and competitive learning, and implemented it to guide students to improve English proficiencies through positive involvement with tablet PCs [49]. Thirty sixth-grade students from an elementary school were randomly assigned into a control group (conventional approach, paper-based crossword game) and an experimental group (using tablet PCs with WiCFG system). The qualitative analysis revealed that integrating the WiCFG system in the collaborative and competitive game-based learning environment led to a better interaction between different levels of students. Students were more active in offering positions, making arguments, and showing support, while those in the control group were only active in posing issues. Some members in the control group reportedly lost their focus during the group collaboration and were ignored by their group members. Additionally, low-achievement students in the experimental group displayed a better learning performance than those in the control group (t = 3.763, p = 0.006).

4.3. Application of Coopetition in Education

This section identifies the specific domains that coopetition has been applied to in educational settings. The review finds that coopetition has been chiefly applied to four domains: (a) cognitive domain, (b) affective domain, (c) social domain, and (d) educational management, as follows.

4.3.1. Cognitive Domain

Studies categorized as being concerned with the cognitive domain are those related to the use of coopetition to improve academic performance and such skills as innovation and creativity [1,4]. The range of academic areas is quite wide, inclusive of language learning [49], mathematical education [64], medical education [62], engineering education [4],

business discipline [1], and computer science [25]. Participants involved vary from primary school students to university students.

4.3.2. Affective Domain

Studies using coopetition in this domain aim to enhance affective factors, such as student motivation, satisfaction, engagement, and learning interest [20,59]. Though high-quality learning resources are accruing, there is an increasing shortage of attention on them [48]. Coopetition, which combines collaboration and competition, provides researchers an effective approach to strengthen students' motivation and learning engagement [25,66].

4.3.3. Social Domain

Studies in this domain investigate the effect of coopetition on improving collaboration, communication skills, and leadership skills, and providing a simulated real-world environment to prepare students for future challenges [47,50,51,53,63]. Intergroup competition reportedly strengthens group collaboration and group cohesion. In the presence of competition, group members are forced to hone their communication skills and leadership skills so as to cope with the challenges effectively [51].

4.3.4. Educational Management

Application in this field is quite rare. It primarily refers to how educational institutes, particularly higher educational institutes, resort to coopetition to stay competitive in the market of education [21,68]. Muijs and Rumyantseva examined the collaboration and competition in a network of 11 colleges in England to see how coopetition informed college strategies and policies [21]. They discovered that competition strengthened genuine collaboration between colleges, which enhanced colleges' competitiveness through network activities such as professional development and mutual support. Sjogren and Fay proposed traditional colleges to build strategic partnership with existing online education providers, which were considered as powerful potential competitors, to facilitate their way into the online education arena [68]. They argued that sharing experience and resources would benefit all parties.

5. Discussion

Overall, three main categories of research topics emerged as a result of the analysis: (a) Organization of coopetition, (b) Medium and coopetition, and (c) Application of coopetition in education. These categories will then be discussed in relation to their importance to the educational field.

5.1. Summary of Organization of Coopetition

Studies on coopetition in the educational field were organized primarily through two ways (see Figure 1): (a) zero-sum coopetition ($n = 15$ out of 33) and (b) social-comparison coopetition ($n = 13$ out of 33). Very few studies were categorized as unstructured coopetition due to the vague and unjustifiable design of collaboration and competition. Findings from the reviewed studies indicate that both zero-sum coopetition and social-comparison coopetition are considered promising designs for contributing to education. Currently, it is difficult to determine which one is relatively better, or specifically, which one is preferable under certain conditions. Solutions for this issue will be of significant value in guiding educational researchers and practitioners in carrying out coopetition-related studies to improve students' learning in the future.

Among the reviewed coopetition studies, collaboration and competition are either directed at the same or different players. This difference may exert distinct influences on how coopetition affects students' learning. The directions of collaboration and competition are as follows:

(a) Directed to different players. In most of the 33 studies, collaboration and competition are directed at different players. This entails having members within a group

collaborate to accomplish certain undertakings, and then compete with members of different groups for rankings/rewards/scores. All studies in the zero-sum coopetition and most of those in the social-comparison coopetition fall into this type.

(b) Directed to the same players. In only a few studies, collaboration and competition are directed to the same players. This means that the same students collaborate with one another, and also compete with one another. This approach is utilized in the within-group collaboration coupled with the within-group competition subcategory in the social-comparison coopetition studies.

(c) Directed to multiple players. Two studies, one from the zero-sum coopetition [50], and the other from the social-comparison coopetition [4], are found to have collaboration and competition being directed to multiple players. In these studies, members collaborate within a group to accomplish group goals; different groups compete with one another for higher rankings/rewards, but they also collaborate with one another, for instance, to set cross-group committees to oversee the competition or to solve complex problems which cannot be done by one single group. Interestingly, both studies found that students preferred intragroup collaboration over intergroup collaboration in the presence of intergroup competition. As M. C. Johnson and Lu reported, most students worked closely with their team members and they did not treat the cross-team committees as resources [50]. Nevertheless, since intergroup collaboration was not highly stressed in the two studies, we did not set another subcategory for them.
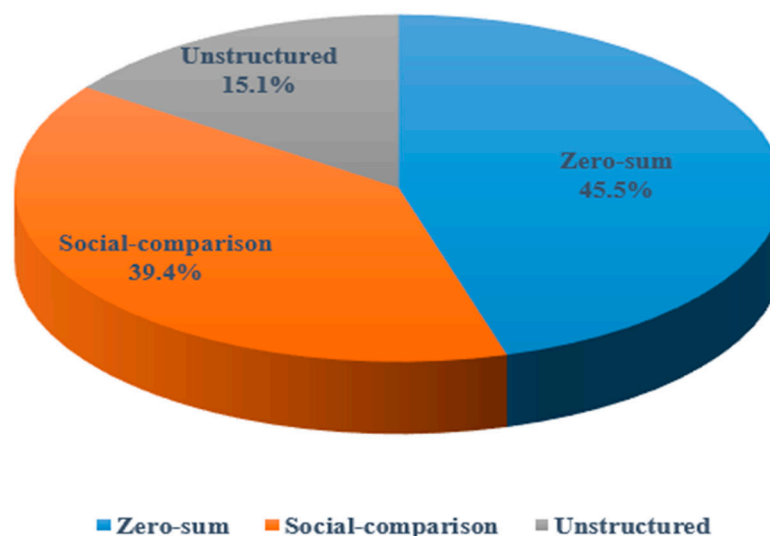

Figure 1. Distribution of Coopetition Studies Organized in Different Ways.

5.2. Summary of Medium and Coopetition

In sum, this section shows that the number of studies carried out in the computer-mediated settings (63%) far surpasses that in conventional face-to-face settings (see Figure 2). It is nevertheless acknowledged here that what determines the learning effectiveness is not the medium per se, but the design of instruction [74], specifically, how collaboration and competition are designed and operationalized through the instructional medium.

However, this does not deny the affordances of different instructional media. Advancements of information and computer technologies (ICTs) have afforded considerable opportunities for coopetitive learning. Educational practices and research studies are increasingly seeking to apply ICTs to facilitate students' learning, thus producing new forms of learning, such as computer-supported collaborative learning (CSCL), game-based learning, and flipped classroom [75,76].
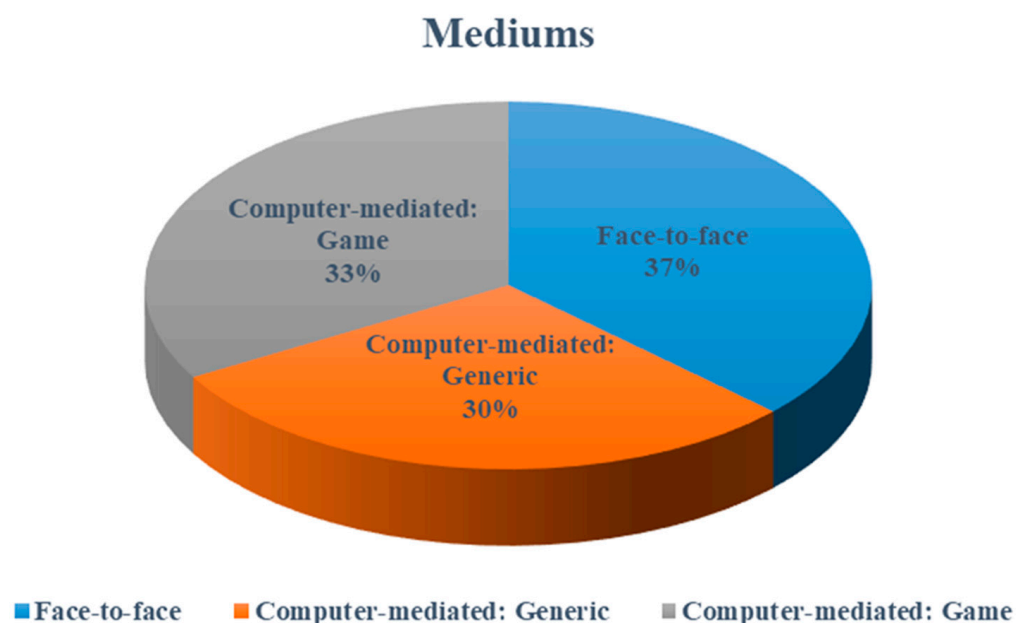
Figure 2. Distribution of Studies Conducted through Different Mediums.

Another interesting observation of this section is that nine out of the 29 studies adopted the computer game-based learning approach. Games have been considered a powerful technique to capture and hold student interest [77]. Muñoz-Merino, Molina, Muñoz-Organero, and Kloos posit that game and competition have a relationship and most games add certain degrees of competition to the learning process [78]. Together, they provide a motivation and enjoyment component that is able to greatly improve the learning process.

Nonetheless, one issue is open to future research. Although most studies used the computer-mediated approach, few have examined how ICTs actually mediate the collaborative and competitive process. Teasing out the possible roles that ICTs play in coopetitive learning will be of considerable value to guide future research examining how to use ICTs more effectively.

5.3. Summary of Application of Coopetition in Education

Coopetition has been applied to the cognitive, affective, and social domains, as well as educational management, and has been shown to be quite effective. Nevertheless, research attention has been too separated in these domains; it would be very difficult to gain deep insight as to how collaboration and competition, respectively and together, affect students' learning and policy-makers' decision-making. Furthermore, considerable efforts have been placed on proving the effectiveness of coopetition in these domains. The potential drawbacks and limitations of coopetition are nonetheless seldom investigated, which may not be good things since full use of coopetition requires a comprehensive understanding of it.

5.4. Critique of Research on Coopetition in Educational Settings

The concept of coopetition has attracted substantial attention from researchers in the business field in recent years. Ever since the journal of *Industrial Marketing Management* published a special issue (issue 2, volume 43) for coopetition in 2014, the research focus is no longer staying at the level of proving the effectiveness of coopetition or comparing it with either collaboration or competition. Increasing effort is spent on exploring effective coopetition strategies. However, research on coopetition in educational settings is still in its infancy, and the term itself is not widely recognized.

Educational settings serve as an ideal testing ground for coopetition. Knowledge is considered as an unlimited resource in the sense that learning in one area does not mean that there is less for others to learn [79]. In coopetition, the gains each group and

each student acquires are infinite. Knowledge will not become less and less after several rounds of competition and division, but will grow exponentially through collaborative and competitive interactions. Individuals in either winning groups or losing groups can benefit substantially from coopetition [80].

While acknowledging the early stage of educational research on coopetition and the limited number of studies directly comparing coopetitive learning with collaborative or competitive learning, it is important to note that we do not claim coopetition to be definitively and unconditionally superior to collaboration or competition.

However, we contend that coopetition holds significant potential for advancing education. Among the reviewed studies on coopetition, none of them reported the common issues associated with collaborative learning, such as lower motivation, free-riding, social loafing, imbalanced responsibility and commitment, and compromised group effectiveness [6]. Similarly, none of the studies reported problems such as disrupted group processes, goal-oriented learning at the expense of the learning process, or detrimental pressures and anxieties often associated with competitive learning [11], with only one study noting some negative attitudes from students [12]. Instead, the majority of studies highlighted the positive effects of coopetition from cognitive, social, and affective perspectives.

One possible explanation for the absence of reported issues in the reviewed studies may be that researchers overlooked or disregarded these issues. Alternatively, it is plausible that coopetition effectively mitigated the potential problems associated with collaborative learning or competitive learning. While it is conceivable for a single study to overlook such issues, it is highly unlikely that 33 studies collectively overlooked them. Although the majority of the reviewed studies support the notion that coopetition addresses these concerns, further systematic research is still required to validate this explanation conclusively. In summary, we strongly believe that conducting equivalent studies in the educational field will make significant contributions to the development of coopetition theory and the enhancement of students' learning experiences. These future studies will provide valuable insights and help further validate the positive impact of coopetition on education.

6. Implications

This review paper critically examines extant studies on coopetition in the educational field to gain a deeper understanding of how the concept has been utilized to enhance education. Originating from the business field, coopetition has long existed in the educational area, but has yet to be widely adopted in the classroom. This is largely due to the pervasive prejudice against competition [69,81], and a current craze for collaboration, which ultimately leads to attention being mainly placed on collaboration-related practices and research. Despite these current trends, this review has indicated that a hybrid approach utilizing the strengths of both approaches may be a better option to facilitate learning in varied educational settings. The insights presented in this review should assist classroom practitioners seeking to enhance their students' learning experience. The review also provides researchers with a starting point to draw on when planning a future research project utilizing coopetition.

An extensive search of the literature yielded 33 studies employing coopetitive research design in learning environments. Findings from these studies were organized according to three categories: coopetition organization, medium and coopetition, and application of coopetition in education.

Several implications can be derived from the preceding studies for educational researchers and practitioners. Firstly, while collaboration is widely acknowledged as a crucial 21st-century skill, it is equally important to teach students how to engage in constructive competition. Coopetition offers a practical learning environment where students can learn to collaborate and compete simultaneously, thereby better preparing them for future challenges.

Secondly, although coopetition has different forms, the learning design is suggested to follow the form of intergroup competition coupled with intragroup collaboration. This may

largely combine the advantages associated with collaboration and competition to produce the synergy for students' learning, while avoiding the potential drawbacks of both.

Thirdly, ICTs have the potential to facilitate coopetition in educational settings. The careful use of them may aid the implementation of coopetition. Thoughtful designs of coopetition through ICTs may largely decrease the potential drawbacks of competition, such as causing pressure and anxiety, and facilitate collaboration to be more effective.

7. Limitations and Future Research

Certain issues have already been discussed at the end of each section. Although the reviewed studies consistently reported positive outcomes as a result of using coopetition, it is important that we address a few more issues with the studies in the review that require attention.

7.1. Simple Treatments on Coopetition

Most studies stagnated at the level of simply adding competition to collaborative learning or vice versa, with few or no further treatments on collaboration and competition. Groups in the whole class/project were simply instructed to compete with one another. This may have created an atmosphere of intense competition where everyone wanted to win, thus resulting in an emergence of severe hostility among the participants. Another complication of this is that it may have created very weak competition where students did not give their best efforts due to vague clues regarding which groups they should compete with. Johnson and Lu point out that competition itself cannot promote high-quality learning [50]. If teams compete within the class without a higher and clearer standard, it is likely that all teams will turn to simple learning strategies. Few studies have explored issues such as how long a coopetition should last for, how to design collaboration to adapt to competition, and vice versa, and whether to set a prize for coopetition or not. Additionally, if prizes are set, what prizes should they be? These issues could exert significant influence on the effectiveness of coopetition and this is something classroom practitioners should consider before utilizing this approach.

7.2. Unclear Knowledge of How Coopetition Works

Extant studies have primarily focused on the cognitive, affective and social outcomes brought about by coopetition. Little attention is nevertheless placed on finding out how collaboration and competition, respectively and together, facilitate or even obstruct the cognitive, affective and social process. Understanding how coopetition works is of great significance to guide the coopetition design in the future and to the development of coopetition theory. Otherwise, it would look like a "black box" where coopetition is in one side and the various outcomes in the other side, but what is in-between is unknown.

Future research is thus suggested to do the following: (a) to explore the fine-grained coopetition-related pedagogical design, (b) between zero-sum coopetition and social-comparison coopetition, to determine which is more effective under what conditions, (c) to examine the coopetition process and find out how it facilitates students' learning, and (d) to concentrate resources on certain domains in order to gain deeper insights into it.

8. Conclusions

This article provides a comprehensive review of the extant studies on utilizing a coopetitive approach to facilitate learning in educational settings. The review identifies three categories of research topics: (a) organization of coopetition, (b) medium and coopetition, and (c) application of coopetition in education, and discusses each category in detail. The article examines each category in depth and draws attention to the potential benefits of both zero-sum and social-comparison designs for enhancing education, particularly in computer-mediated settings. Coopetition has been shown to be effective in cognitive, affective, social, and management domains. Compared with the binary thinking that creates divisions, coopetition provides a rationale for blending the cooperative and competitive

elements of educational practices. By embracing the concept of coopetition, we can create a more balanced environment that encourages collaboration among individuals while still maintaining a healthy competitive spirit. This approach can fuel innovation, creativity, and productivity in education. However, more research is needed to better understand the possible drawbacks and limitations of coopetition and to compare it with collaborative learning or competitive learning. Overall, this article highlights the importance of considering a coopetitive approach that leverages the strengths of both collaboration and competition, while minimizing each one's weaknesses, to enhance students' learning in educational settings.

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