The Role of Gender in Collaborative Learning

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The manner in which social context contributes to children's learning has long been of interest to developmental psychologists [1]. No doubt learning requires cognitive ability heavily; nevertheless, studies have compared individuals in group with individuals working alone and found that those who collaborated with others performed better in their individual learning post-tests than their counterparts who worked alone [2]. This result may reflect that cognitive capability is only a partial answer to the understanding of learning process, while other factors such as social collaboration should also be taken into account. Vygotsky and Piaget are two influential developmental psychologists that support this idea [3]. They both deemed that peer collaboration is likely to improve individuals' cognitive capability and thereby advance their learning outcome. They emphasized two very different approaches in order to achieve so. Vygotsky advocated that language is a cultural and psychological tool that allows people to establish share meanings and structure the content of individual thoughts through the use of dialogues like discussion [4]. Then the construction of a mutually satisfying meanings by coordination and the integration of two or more peoples' differing perspectives are likely to lead to cognitive improvement and acquisition of the share meaning. This idea was empirically confirmed by Hatano and Inagaki [5]. On the other hand, Piaget highlighted that learning is the outcome of equilibration [6]. This is a process that involves the reconciliation by individuals of conflicts between prior and newly experienced beliefs. This process is likely to result in cognitive change and learning of the reconciled knowledge. This view was demonstrated by Doise and Mugny [7]. Overall, whatever approaches, they both consistently suggest the effectiveness of collaborative learning.

Nevertheless, a number of studies have criticized not all individual can benefit equally from it [8,9]. How much each individual can benefit from collaborative learning varies based on multiple factors such as gender differences.

Hence, this essay will discuss how gender moderates the effect of collaboration on learning by evaluating the influence of individual gender effects, gender composition and the ratio of the group.

Firstly, Ding, Harskamp and Suhre [8] found that females did not benefit as much as males from collaborative learning. In this experiment, they investigated their problem-solving process on Newtonian mechanics. Participants were asked to solve three new and moderately structured problems with their partners. The result suggested that, after discussion, males and females improved 22% and 10% respectively when comparing their individual pre-and post-tests.

Accordingly, this documented that boys tend to benefit more from collaborative learning compared to girls. Bearison, Filardo and Magzamen [10] explained that boys and girls have different communication styles and therefore this may result in benefit to boys more than that to girls. They indicated that girls are prone to disagree with no further justification, whereas boys tend to disagree with concrete evidences and explanations. Some research tried to tie this distinction with the self-explanation effect [11]. That is, when boys explain their arguments to their group mates, they are at the same time self-assessing their understanding of the argument in mind. Thus, this internal process is likely to improve boys' understanding of the issue and improve their learning outcome of it. By contrast, whilst girls provide vague disagreement, this processing is less likely to be triggered in girls. This provides a cognitive explanation of why boys may benefit more from collaborative learning than girls.

Nevertheless, empirical research on the association of verbal disagreement with explanation and cognitive processing is limited. Further research in this field is recommended.

On the other hand, a contrary research was found [9]. This was a real classroom experiment with high ecological validity. Participants were students enrolled in a digital design class and each of them were grouped with three other participants. They were required to complete multiple choices as pre-test in their first class. During the semester, participants were required to post their thoughts and questions to the online discussion board in group. Moreover, after each class, participants reflected about the content learned in the class and discuss assignments with their group mates. The result demonstrated that girls improved 10% more than boys in their individual post-tests at the end of the semester. Although this experiment is criticized that it could not control interaction outside the classroom and this might affect the result, it is still strongly believed that it provided an empirical evidence to imply that girls may benefit more than boys from collaborative learning. It is observed that girls are more likely to work toward a consensus and therefore they may benefit more than boys [12]. This suggestion is in line with Vygotsky's idea which highlights that an effective collaboration depends upon the establishment of share meaning, so girls in this way may improve more.

To evaluate the two contradictory findings, perhaps, a child's learning effectiveness cannot simply be interpreted by his or her gender. Rather, it depends on the context of participation. Ding, Harskamp and Suhre [8], who found that boys improved more from collaborative learning, required interaction with opposite-gender participants, whereas Fong, Liang, Mei and Zhan [9], who stated that girls benefit more, investigated same-gender collaboration. Based on these differences, it is argued that group composition with respect to gender seems more likely to be a greater moderator on the effects of collaborative learning than individual gender differences.

In order to examine the effectiveness of gender composition on collaborative learning, Bosker, Ding and Harskamp [13] randomly paired participants with a same-gender or an opposite- gender partner to overcome a number of structured problems related to Newtonian mechanics across two weeks. The comparison of the per-and post-tests demonstrated that all participants who collaborated with others improved in their individual post-tests while participants who worked alone had no improvement, despite this improvement was criticized that this might be due to more practice sessions offered for collaborative participants than alone participants during the two weeks. Most importantly, the result further found that male participants performed identically well in both same-gender and opposite-gender groups. Bosker and his colleagues observed that boys reacted equally active no matter what gender they were paired with and, perhaps, this consistency of communication style leads them benefit from collaboration regardless of gender composition.

However, Duveen and Psaltis [14] assigned boys to work with either more-able males or more- able females so as to solve a task of conservation of liquid. Learning improvement was assessed by their pre-and post-test differences. As a result, boys who interacted with girls improved the most compared to those grouped with boys and those working independently. This result is against Bosker, Ding and Harskamp [13]. Additionally, unlike Bosker and his colleagues' observation, Duveen and Psaltis found that gender composition is likely to influenced the type of conversation that boys used in their discussion. Boys were more likely to disagree with their female partners than their male peers. This is in line with Piaget's idea that boys with female partners are thus likely to re-examine their initial knowledge cognitively and need to recognize a higher order solution to the problem which resolve the apparent conflict. Hence, they may understand more and improve more eventually from collaboration. By contrast, as there was less disagreement, this socio-cognitive process is less likely to be generated in boys who interacted with other boys and hence they may improve less. Nonetheless, rather than seeing the two studies as contradictory, this is better to perceive the current research as an extension of Bosker and his colleagues' one. That is, other individual differences, such as ability, may interact with gender composition in influencing the effectiveness of collaborative learning.

Moreover, a number of studies have shown that distinct gender composition may impact learning effectiveness in girls [13]. Secondary-school girls were grouped with males or females to overcome moderate physics problems in a two-week experiment. By comparing their individual per-and post-tests, girls with other females outperformed their counterparts who worked with males. Similar result was documented by Ding and Harskamp [15] who recruited Chinese students in Shanghai. These findings are thus culturally valid for

demonstrating that, unlike boys, gender composition matters to girls and single-gender is superior to mixed-gender for girls. Underwood and Underwood [16] observed that girls who interacted with same-gender group mates were more likely to joke and laugh with each other, therefore they were less stressful in the conversation compared to those in mixed-gender composition. This observation is further elaborated by Berdondini, Kutnick and Ota [17] through the idea of spring. While same-sex girls feel less pressure, they are more likely to build trust with and support each other compared with mixed-gender group. This positive interpersonal relationship therefore leads these girls to respect each other's opinions more and facilitates the establishment of common consensus emphasized by Vygotsky. Thus, this superior peer collaboration is likely to lead to a more outstanding learning outcome in girls interacting with same-sex peers than interacting with mixed-sex group mates.

Nevertheless, the conclusion of girls being unlikely to benefit from mixed-gender composition is criticized by Webb [18]. His main argument was that mixed group can be categorized into balance and imbalance mixed gender composition and whether a girl or a boy can benefit from mixed-gender group mates depends on the gender ratio of the group. It is because males and females are likely to interact differently in different gender ratio and this may result in uneven benefit to the girls and boys from the group.

Webb [19] found that girls were unlikely to benefit from collaborative learning in imbalanced mixed-gender groups, whereas opposite phenomenon was found in boys. Boys and girls were randomly assigned to groups of three females and one male or groups of one female and three males to learn mathematics. The result suggested that no significant improvement was found in girls in their individual measurements regardless of gender ratio, however boys improved identically well in both majority male and majority female compositions. Webb observed that boys were more likely than girls to give and receive elaborated explanations and they were more likely to be requested for help from their group mates. This may trigger the self-explanation effect as discussed and therefore lead boys benefit from collaboration. However, on the other hand, girls' responses were often ignored by their male peers and boys usually dominated the conversation in both majority male and majority female groups, leading girls fail to achieve the dyadic interaction highlighted by Vygotsky's and Piaget's ideas of a successful collaborative learning. Therefore, this gives an explanation of why girls may not benefit from imbalance gender ratio. Nevertheless, Barnes, Joiner, Keogh and Littleton [20] found that boys' dominance significantly reduced when they participated in a language task compared to a computer-based task. This may imply that boys have greater dominance in areas that they are more interested in or talented at. This again suggests that other elements, such as task nature in this case, may interact with gender composition in influencing the effect of peer collaboration on learning.

Despite imbalanced mixed group seems only benefit boys instead of girls, balanced ratio benefit both consistently [18]. Secondary-school students collaborated with two males and two females for two weeks to learn exponents and scientific notation. Two weeks later, both males and females achieved significantly well in their individual post-tests. Webb noticed that males' dominance had shown improved and more even contribution to group work between genders was found in balanced mixed composition. This means that, unlike imbalanced gender group, there is a two-way discussion in equal ratio. This therefore allows individuals to express their perspectives and to generalize different perspectives into one share meaning and then to reconcile individual conflict in mind. This cognitive improvement is likely to advance boys' and girls' interpretation of the discussed issues and hence they may learn the issues better than before. Accordingly, both boys and girls are able to benefit from collaborative learning when it is an even gender composition.

Gender composition	Boys	Girls
Same gender composition	Yes	Yes
Opposite gender composition	Yes	
Mixed gender composition		
Balanced mixed gender ratio	Yes	Yes
Imbalanced mixed gender ratio	Yes	

Table 1: *Summary of studies that boys and girls may benefit from collaborative learning according to different types of composition.*

The result that females tend to benefit from same-gender and balanced ratio groups while males benefit from all sorts of gender ratio compositions has vital implications for schooling and accordingly maximizing students' learning capacities. Teachers in co-educational schools are recommended to assign children to same gender or balanced mixed groups for group activities as these two types of composition are going to benefit all students and guarantee consistent cognitive improvements on both genders. Teachers are, at the same time, suggested to pay attention to a number of factors, including the nature of the task and the ability difference among peers, that may have influence on the effectiveness of collaborative learning. As discussed, boys interacting with more-able girls outperformed boys cooperating with less-able girls and same-sex peers regardless of their ability [14]. Hence, teachers are proposed to encourage interaction between less-able boys and more-able girls. Additionally, imbalanced ratio group is relatively discouraged. However, if the imbalanced mixed group is inevitable, teachers are advised to modulate the task nature in order to improve the asymmetrical gender benefits from collaboration. For example, Barnes, Joiner, Keogh and Littleton [20] found that girls improved less because boys dominated the interaction in imbalanced gender group, but this dominance abated if the task was not a male-preferred task. Accordingly, teachers are suggested to allocate students to an art task instead of a science assignment, so that both genders may as well be beneficial.

To conclude, evidence suggests that collaborative learning does not benefit everyone identically and how much each individual can benefit from it varies according to multiple factors such as gender differences. Nevertheless, contradictory results were found. Some studies demonstrated that boys' learning outcomes improve more than that of girls, whilst other research documented that girls outperform boys. Hence, this means that, perhaps, a child's learning effectiveness cannot simply be interpreted by his or her gender, but rather the context of participation such as gender composition. It is found that boys benefit from both same-gender and mixed-gender groups while females only benefit from the same-gender group. However, it is criticized that the mixed- gender group can be classified into balanced and imbalanced gender ratio compositions. As a result, females tend to benefit from same-gender and balanced ratio groups while males benefit from all sorts of gender ratio compositions. Nonetheless, it needs to be aware that the effect of peer collaborative learning may be impacted by the ability differences between group mates as well as the nature of the task. Lastly, all these findings provide significant implications for schooling in order to improve students' learning.

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