MASTER THESIS

Formal vs Informal Cooperative Learning: The Effect on Students' Perceived Competence and Conceptual Knowledge Gain

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Abstract

Cooperative learning is an essential tool to equips Indonesian learners in dealing with the demands of 21st century skills. However, the implementation of cooperative learning faced common challenge, namely social loafing. This challenge arose the need of more research regarding the structuring process in cooperative learning, specifically in Indonesia as the main context. This study compared the efficiency between *formal* and *informal* cooperative learning conditions, investigated through the extent of differences on students' perceived competence and conceptual knowledge gain. This study specifically investigated whether students' subjective appraisal towards task value and group process led to better-perceived competence and conceptual knowledge gain. Seventy two students in two public junior high-schools in Indonesia were participated in this study. There were two conditions, *formal* and *informal* that differs in individual accountability with pre-assigned roles, feedback systems, and guidance. Results indicated no substantial outcome differences between the two cooperative learning conditions, despite the ability of both cooperative learning conditions to improve students' perceived competence and conceptual knowledge gain. Interestingly, the formal cooperative learning group appraised overall task value and group process value more positively. Group process value was positively associated with students' perceived competence in formal condition. In contrast, group process value was positively correlated with task utility value in informal condition. Neither of the subjective task value (i.e., group process and task utility) and students' perceived competence was positively correlated to conceptual knowledge gain. In conclusion, both formal and informal cooperative learning are mutually promising as learning strategy methods. In the actual classroom implementation, the teacher should consider the complexity of learning content, time constraint, and prior learner experience with cooperative learning into account.

Keywords: formal cooperative learning; informal cooperative learning; conceptual knowledge; self-perceived competence.

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1. Introduction

What does it mean to be a learner in today's world ?. The development of technology and globalization, which marked the emergence of the 21^{st} century, has an enormous contribution in shaping the evolving cellular changes in society. This era of the 21^{st} century placed greater emphasis on knowledge, mobility, and collaboration (Dunning & Lundan, 2008). In accordance to the notion, necessary skills attributed to the 21^{st} century, such as; higher thinking skills, digital literacy, problem-solving skills, and specifically collaboration skills are beneficial to equip learner in their adjustment as a member of global society. As referenced from Johnson and Johnson (2014), collaborative skills would be pivotal to endure the rapidly increasing global interdependence and local diversity.

The circumstance, as mentioned above, created a shift in the educational sector, that the definition of a learner supposedly expands from 'someone who passes the test' to be 'someone who passes the test, capable in implementing their knowledge and work as a team'. As a response to the learners' need of having 21^{st} century skills, specifically collaboration skills, many countries raise the awareness in their curriculums design. For instance, Singapore curriculum which emphasized on project-based learning to promote higher order engagement among the students. Malaysia and Hong Kong that focus on the development of students' interpersonal and communication skills, therefore, emphasizing the use of cooperative learning as an alternative to traditional method of teaching. Hong Kong even had established *the Centre for Learning Enhancement and Research* in 2000 in order to boost the implementation of cooperative learning.

Indonesia, as an economically growing country with 65 million young people population, aged from 10 to 24 years (UNESCO, 2018), reciprocates the demands with *Kurikulum-13* (K-13). *K-13* is a new curriculum established since 2013, which carried out significant changes in the teacher-student approach, the learning goals which balanced of hard-skills and soft skills, activity-based learning materials, and integrated thematically; and the more comprehensive assessment process which include local wisdom. The changes were meant to nurture character building, the ability to think critically, the ability to consider the moral aspect of a problem, the development of collaboration and communication skills (Ministry of Education and Culture, 2017). Therefore, teachers are required to be resourceful and innovative with the learning strategy or model to evoke a pleasant yet meaningful learning environment.

Having the goals mentioned above, the new curriculum is facing challenge in the classroom implementation level. Particularly in choosing the appropriate teaching strategy that accomodate the development of higher thinking, communication and collaboration skills but time-sufficient. As referenced from Gunawan (2017), based on his research in seven elementary schools in Malang City, East Java Province, Indonesia, that challenges faced by teacher in implementing K-13 were mostly saturated in teachers' difficulties in splitting their focus between implementing learning plan and the administration function as a teacher. Therefore, affecting the learning plans and models execution. Separately, the lesson plan execution was also a glaring problem in K-13 implementation in West Seram District of Maluku Province, which caused by the lack of teacher readiness to conform their teaching strategy to fulfil the requirements addressed by K-13 (Rumahlatu, Huliselan, & Takaria, 2016). Therefore, the challenges displayed were time constraints, teacher readiness to shift from a heavily *'one way'* teaching, and how distinctive cultures in Indonesia might vary the teaching strategy needed to manage the learning objective of *K-13*, which aiming for 21st-century skills development.

Supporting the teacher to achieve this one goal, having a small group discussion or cooperative learning group is suggested in every unit within the standardized textbook throughout different subjects. Take Science, for example, *ayo kita diskusikan'* ('let's discuss) or in science textbook made to facilitate *'small experiment'* (Ministry of Education and Culture, 2017; Ministry of Education and Culture, 2013). Cooperative learning was proven to give the learner the opportunity for active discussion, problem-solving, and generate elaborative feedback among peers which can be associated with advances in a range of cognitive competencies, including problem-solving skills, conceptual understanding, and the metacognitive reasoning (Gauvain & Perez, 2007; Rogoff et al., 2007). Interestingly, findings also reported that the advantages from cooperative learning implementation also cover the enhancement of academic self-concept or self-perceived competence in tow with the escalation of intrinsic motivation (Guay et al., 2010; Slavin, Hurley, & Chamberlain, 2003).

Academic self-concept or self perceived competence plays a pivotal role as a predicting factor, in the process of skills application to be a form of actual academic performance. For instance, in a meta-analysis study variables (i.e.,105 predictors) associated with achievement, it was reported that students' perceived competence, which was second only after peer assessment as the strongest predictor of academic achievement (Schneider & Preckel, 2017). Therefore, cooperative learning is a potential learning strategy for the 21^{st} century skills development and ensure students has the necessary belief carried out the presentation of the skills mentioned.

However, the potency of cooperative learning can be crippled by an ineffective group process. The common problem associated would be social-loafing, in which the tendency for individuals to allocate lesser effort when working collectively (Latané, Williams, & Harkins, 2006). This problem also happened in the target population of junior high school students in Medan. Based on the observation at June 2019 in two public junior high schools in Medan and Tanjung Morawa (i.e., *SMP Negeri 1 Medan* and *SMP Negri 3 Tanjung Morawa*), it was concluded that the teacher had massively implemented small group learning in their teaching strategy yet not all of the team members were engaged in the group discussion and only one student whom the most active in the group ended up presenting the result. As described, social loafing and their casual occurrences in cooperative learning are not only decrease the potency of the learning strategy and left learning objectives unachieved, but also creates negative connotations associated with cooperative learning among students. Aggarwal and O'Brien (2008) reported that social loafing served as the most negative influence on group effectiveness thus overshadowed the entirety of group experience. In the long haul, students recognized social loafing as the primary complaint as to why they dislike group projects (Williams & Karau, 1991).

Then, 'why and how social loafing could emerge?' becoming the next critical question. As referenced from Webb (1997), the main reason from the occurrences of social loafing was "the efforts do not matter or that no one will know whether they contribute.". This notion indicated that the lack of individual accountability and positive interdependence in a group might be the trigger of social loafing to happen in *SMP Negeri 1 Medan*, *SMP Negeri 3 Tanjung Morawa* as observed in the initial survey prior to this study. In order to decrease the possibility of social loafing, the cooperative behavior supposed to be structured, as the more structured the cooperation, by following the principle mentioned above, the more likely for successful group work and group-outcome (R. E. Slavin, 1983).

There are three elements which are considered essential in structuring a cooperative learning. Addressing the first problem of individual accountability, pre-assigned roles for students is essential to equalize participation in the group tasks (Kagan, 1990a). Secondly, the combination of shared-resource, joint-group outcome, individual, and group evaluation would be tested to address the issue of positive interdependence, which in various researches was necessary to achieve learning goals (Moreno, 2009; Supanc, Völlinger, & Brunstein, 2017). Thirdly, to guide the cooperative behavior, the application of collaboration script in cooperative learning also can be implemented as an additional 'structuring device' and led to better involvement in cooperative learning (Van Boxtel, Van der Linden, & Kanselaar, 2000).

Regarding the structure of cooperative learning as a teaching strategy, Johnson and Johnson (1994); suggested two types of cooperative learning for short term implementation; formal cooperative learning which appears to be stricter in structure (i.e., the responsibility of each assigned roles are clearly defined), and informal cooperative learning groups which less strict in structure. Both cooperative learning strategies could be an alternative for Indonesian teachers to nurture 21st-century skills altogether without damaging the time constraint. The fair comparison between the two cooperative learning strategies and how well they could adhere to the big class (i.e., 30 to 36 students) were not yet investigated in Indonesia context. On the other hand, the further investigation concerning the sufficiency of alternative learning strategies is required to facilitate and provide better learning environment and experience for students and teacher.

Thus, the primary aim of this study was to compare and analyze the practicalities between these two cooperative learning conditions (i.e., formal and informal cooperative learning) inspected through their impact on students' perceived competence and conceptual knowledge in the scope of Indonesian students specifically *SMPN 1 Medan* students. The secondary aim was to compare and analyze the effect of cooperative learning conditions towards how students perceived the learning tasks (i.e., subjective tasks values), and whether the perception would be correlated towards students' perceived competence and conceptual knowledge gain in the scope of Indonesian students specifically *SMPN 1 Medan* students.

1.1. The cooperative learning : formal and informal.

Cooperative learning defined as "*group learning activity organized so that learning is dependent on the socially structured exchange of information between learners in groups and in which each learner is held accountable for his or her own earning and is motivated to increase the learning of others.*" (Olsen & Kagan, 1992). Johnson, Johnson and Holubec, 1994 argued, there are five essential elements that should be taken into account for a lesson to be cooperative, such as; *positive interdependence* (e.g., members attainment and group attainment are interrelated); *face-to-face promotive interaction* (e.g., members promoting each other learning); *individual accountability* (e.g., performance of each member is assessed and contributed to the group final mark); *social skills* (e.g., the externalization of personal ideas in group forum); and *group processing* (e.g., group reflection concerning group dynamic and members' contribution). In accordance to the above-mentioned five elements, Johnson and Johnson (1994, 2002) divided cooperative learning into two strategies based on different grasp between the elements which appropriated for temporary and short term use; formal and informal cooperative learning. The application of the above-mentioned elements in structuring formal and informal cooperative learning conditions can be seen in Appendix 1.

1.1.1. Formal Cooperative Learning

In *formal cooperative learning,* students working together for one class period or onto several weeks, to achieve shared learning goals and complete jointly specific tasks and assignments (Johnson et al., 1994). Johnson and Johnson (2002) explains the two main characteristics of the implementation of formal cooperative learning; role (i.e., responsibility in a group assignment) and feedback system (i.e., feedback from both the group members and the teacher). Johnson and Johnson (1989) suggested, the implementation of formal cooperative learning is desirable, when; learning goals are supposedly important, the task is complex or conceptual, problem-solving is required, divergent thinking is desired, higher-level reasoning strategies and critical thinking are needed, or students' social skills development is the major instructional goals. Formal cooperative learning is stressing on the existence of structure. Findings support the idea that structure is indeed crucial for successful teamwork, group-outcome, and individual achievement (Archer-Kath, Johnson, & Johnson, 1994; Aronson & Patnoe, 1997; Kagan, 1985; Slavin, 1983, 1995). For instance, Supanc et al., (2017) found that highly-structured cooperative learning conditions equipped with; cooperation-fostering tasks, group rewards based on individual performance, feedback system, facilitated the acquisition of new knowledge but failed to improve students' perceived competence compared to the low-structured cooperative learning.

1.1.2. Informal Cooperative Learning

Informal cooperative learning is relatively implemented during direct teaching to manage students' attention to the learning material and ensure that students are intellectually stimulated by organizing, explaining, summarizing, and integrating the material into existing conceptual networks (Kagan, 1985). Generally, the implementation of informal cooperative learning is formulated for students to be engaged in short focussed discussions (3-5 minutes) before or after a lecture which distributed throughout the lecture. The apparent difference derived from those as mentioned above (i.e., formal cooperative learning), is the role and feedback system which appeared to be less structured and, therefore, less expected compared to formal cooperative learning. Supanc et al., (2017) argued, despite the superiority exhibited by highly-structured cooperative learning, it has failed to improve students' perceived competence relative to low-structured cooperative learning. The rationale proposed by Supanc et al., (2017) was the possibility of students in low-structured cooperative learning condition were overestimating their knowledge as the group members received no feedback for individual achievement.

1.2. Structure in cooperative learning

Numerous findings had reported that the benefits of cooperative learning were highly dependent on the specific design or structure of the cooperative learning groups or the disposition of group interdependence and individual accountability being in a necessary condition to achieve learning goals (Berger & Hänze, 2009b; Ginsburg-Block, Rohrbeck, & Fantuzzo, 2006; Moreno, 2009; R. E. Slavin et al., 2003; Supanc et al., 2017). Teng and Luo (2015) even indicated that the enhancement in positive group interdependence resulted in positive affective tone within the group and led to an increase in group performance and group learning effectiveness. The detailed explanation of the structuring procedure can be seen in Appendix 1. The structure was created according to variations in types of learning and cooperation, students' roles and communication patterns, teacher roles, and evaluation (Kagan, 1985). Findings reported the relation between structure and efficaciousness of small-group learning in knowledge gain process by mentioning that the small group learning which combined group goals and measures on individual performance is more likely to produce a beneficial effect for students learning and shared learning (Ortiz, Johnson, & Johnson, 1996; R. E. Slavin, 1983, 1995).

1.2.1. Roles assignment in cooperative learning

The rationale of specific role assignment in cooperative learning is to provide positive team identity (Kagan & Kagan, 2009). Role assures team members that they are on the same side with the same goals, thus encouraged them to work together. Kagan also mentioned that role is beneficial to equalize participation since students are assigned to a unique role with a unique task. For instance, in *'4S brainstorming'* (Kagan, 1990b), the roles consisted of ; *Speed Captain* (ensure the coherence between time allocation and discussion), *Super Supporter* (moderator of the group, generates new idea/ encourages members to generate ideas), *Synergy Guru* (encourages members to build upon one another's ideas and concludes the ideas), and Recorder (writes ideas and evaluates ideas). This structure is stressing on the delivery of ideas which beneficial to induce critical and creative thinking.

1.2.2. Collaboration script

Students who are a novice in cooperative learning might need additional prompt to exude expected cooperative behavior. The application of *collaboration script* in cooperative learning serves as an additional *'structuring device'* to produce better involvement in cooperative learning. For instance, Van Boxtel, Van der Linden, and Kanselaar (2000) proposed collaboration script that contained different learning arrangements, which led to better knowledge gain and participation in group project. Separately, van Dijk, Gijlers, & Weinberger (2014) also reported that the positive effect of the script was found conducive to knowledge recall by increasing students' engagement in domain-related information processing activities (i.e., making student study and re-study the concepts).

1.2. The structure of cooperative learning and students' self-perceived competence

According to Shavelson, Hubner and Stanton (1976), self-concept are multifaceted, a hierarchical construct which is divided into academic and non-academic self-concepts. Marsh (1990) explained that academic self-concept or broadly defined as general academic self-concept comprises by more specific facets of self-concept, which in the pre-revised version divided into four facets of self-concepts (English, history, math, and science). Findings reported of the linearity of perceived competence to actual academic performance (Chiu & Klassen, 2010; Huang, 2011; Marsh & O'Mara, 2008; Möller, Pohlmann, Köller, & Marsh, 2009; Valentine, DuBois, & Cooper, 2004). The relationship portrayed to be reciprocal, which self-perceived competence influenced achievement that in turn influenced the perception of one's competence (Guay, Marsh, & Boivin, 2003; Marsh & Craven, 2006). Thus, having a negative self-perception of one's competence appears to hinder the execution of the actions required for learning and academic achievement. Contrary, positive self-perception appeared to help students engage in the task and thus have a positive effect on academic achievement.

In the relation of perceived competence and cooperative learning as a learning strategy, findings found that implementation of cooperative learning will increase intrinsic motivation and elevate the sense of academic self-concept or self-perceived competence (Guay et al., 2010; Slavin et al., 2003). According to Harter (1978), this idea was mostly associated with the successful effort at solving problems as a group or individual, and developing the sense of competence or an internalization of the group reward system to a self-reward system. The combination that subsequently serves as a mediator of motivational orientation which resulting enhancement of children's self-concepts as learners (Nastasi & Clements, 1991). Berger and Hänze (2009a) reported that highly-structured cooperative learning gained higher level of self-perceived competence but in turn gained lower level of autonomy. In the same vein, Supanc et al.,(2017) argued that less-structured cooperative learning group gained lower level of enjoyment in their coursework compared to high-structured cooperative learning group. Contrasting the findings above-mentioned, Moreno (2009) reported that students in jigsaw group (i.e., highly-structured cooperative condition) gained a lower level of situational interest compared to less structured cooperative group. Therefore, the structure in cooperative group played a contributing role in students' perceived competence.

1.3. The structure of cooperative learning and conceptual knowledge acquisition

Krathwohl and Anderson (2009) explained conceptual knowledge is the interrelationships among basic elements within a larger structure that enable them to function together. The latter consist of knowledge of categories and classifications and the relationships between and among them (more organized form). Many studies revealed that cooperative learning has a positive correlation with conceptual knowledge acquisition by giving opportunity for the students to involve in an active discussion, problem-solving, and generate elaborative feedback among peers which can be associated with advances in a range of cognitive competencies, including problem-solving skills, conceptual understanding, and the metacognitive reasoning in samples ranging from preschool to high school (Gauvain & Perez, 2007; Rogoff et al., 2007). The process of communicating and explaining their ideas and knowledge to each other stimulates them to learn from each other while potentially making them aware of a gap in their reasoning, which in the long run will help to increase the understanding of the domain knowledge (Van Boxtel et al., 2000).

Learning theories emphasize the importance of the active construction of knowledge and that this develops over time and with experience (Koohang & Paliszkiewicz, 2013; Lee, Lajoie, Poitras, Nkangu, & Doleck, 2017). n a more structured cooperative learning condition, students are encouraged to adopt an active role and to be responsible for others' learning. Thus, it is a process where learners are actively regulating joint activities and coordinating their tasks (Vuopala, Hyvönen, & Järvelä, 2015). Active participation, along with the responsibility assigned for the students in cooperative learning, is beneficial to boost knowledge construction. In accordance to the findings mentioned, a highly-structured cooperative learning strategy (i.e., formal group, jigsaw groups) supposedly resulting better conceptual knowledge gain compared to the less-structured cooperative learning, considering less necessity for students to be responsible for others learning. The result from Jurkowski and Hänze (2010) as mentioned in Supanc et al., (2017) supported the claim, that the more structured cooperative learning group did better on conceptual knowledge test than the less-structured cooperative learning group. Yet, it can be concluded that structure in cooperative behaviour or group was indeed important in knowledge construction.

1.4. Present study

The above overview of the literature indicated that the benefits of cooperative learning are highly dependent on the specific design or structure of the cooperative learning groups. Teachers are advised to build the lesson plan in specified academic and social goals, learning group structure (size, roles to assign, material arrangement), cooperative task structure, and cooperative rewards system. The opportunity of face-to-face interaction is also expected in informal cooperative learning in which short shared-learning tasks were constructed and appropriated into three-to-five minute turn-to-your-partner discussions interspersed throughout a lecture (i.e., before and after learning material was presented).

In this study, group interdependence was ensured by giving different roles (i.e., formal cooperative group) to the team members during learning and individual worksheet to monitor and foster students' involvement in the group work. Individual accountability was ensured by informing students that each member would be individually assessed (with conceptual knowledge task) on his/her learning after working with their peers on the task. In addition, students were asked to determine their satisfaction towards members' contributions (i.e., individually assessed) and group-outcome.

Furthermore, this study was ensured that the two cooperative learning conditions were clearly defined *'individual accountability'* (i.e., appropriated to the cooperative learning conditions) along with the set of procedures that would be explained more in the next section (see procedure section). Besides, to foster cooperative behavior, this study was incorporating script in group worksheets to explain and direct individual responsibility and individual involvement in the group project. Based on the pilot study, it was concluded that the script was enough to direct and foster cooperative behavior in formal cooperative group setting while aiding the domain knowledge learning process. Cooperative learning material and tasks complexity were another critical focus to ensure the occurrence of cooperative behavior which cognitively demanding tasks would benefit group learning more than the cognitively undemanding ones (Janssen, Kirschner, Erkens, Kirschner, & Paas, 2010; Kirschner, Paas, & Kirschner, 2009a, 2011).

In this study, formal cooperative learning materials and tasks were formed as "multi-structural" lessons in which each structure provides a learning experience upon which subsequent structures expand, leading toward pre-determined academic, cognitive, and social objectives or along the way functioned as interpretative support in structuring domain knowledge.

This was essential concerning students was expected to build their domain knowledge based on tasks, materials and group discussion. While the teacher support and individual worksheet were situated as a reflective support towards students' learning process. Separately, in informal cooperative learning, task was served as a validation and confirmation that students were cognitively present in the classroom. Despite teacher's presence as the main source of interpretative support, learning tasks were needed to solidify students' grasp to the domain knowledge. Both of the cooperative learning conditions could be a useful learning strategy options, but which that more beneficial for students (i.e., both for perceived competence and conceptual knowledge gain) was still questionable.

Therefore, the purpose of this research was to investigate and compare the difference between these two cooperative learning implementation on students' perceived competence and conceptual knowledge gain. In particular, the present study sought answers to the following research questions:

(a) How do the two cooperative learning conditions differ in students' perceived competence and students' conceptual learning gain?;

(b) How does the implementation of '4S roles' in formal cooperative learning affect students' perceived competence and students' conceptual knowledge gain?;

(c) How do the two cooperative learning conditions differ in students' appraisal towards tasks utility value and group process value?;

(d) How do students' appraisal of task utility value and group process value affect their result on conceptual knowledge and perceived competence test?.

Based on the above-mentioned main research questions, seven sub-questions were developed:

(a) How do the two cooperative learning conditions differ in the estimations of students' self-perceived competence?

(b) How do the two cooperative learning conditions differ in students' performance on conceptual knowledge test?

(c) How does the role assignment (i.e., *4* roles) influences the estimation of students' self-perceived competence?

(d) How does the role assignment (i.e.,*4* roles) students' performance on conceptual knowledge test?

(e) How do the two cooperative learning conditions differ in students' appraisal towards *task utility*?

(f) How do the two cooperative learning conditions differ in students' appraisal towards *the group process*?

(g) How do students' appraisal of task utility value and group process value affect their result on conceptual knowledge and perceived competence test?.

Based on the above-mentioned research questions, seven hypotheses were proposed:

Hypothesis 1 : Students in formal cooperative learning groups would estimate self-perceived competence more positively compared to students in informal cooperative learning group.

Hypothesis 2 : Students in formal cooperative learning groups would perform better in conceptual knowledge test compared to students in informal cooperative learning group.

Hypothesis 3 : Roles assigned (i.e.,*4* roles) in formal cooperative learning would influence students to obtain differences in self-perceived competence.

Hypothesis 4 : Roles assigned (i.e.,*4* roles) in formal cooperative learning would influence students to obtain perform differently in conceptual knowledge test.

Hypothesis 5 : Students in formal cooperative learning would appraise task utility value more positively than would students in informal cooperative learning.

Hypothesis 6 : Students in formal cooperative learning would appraise group process value more positively than would students in informal cooperative learning.

Hypothesis 7 : Students' appraisal of task utility value and group process value would influence their result on conceptual knowledge and self-perceived competence test.

To examine the hypotheses, an experimental study was conducted in which students were divided into two conditions, formal and informal cooperative learning. Students in formal cooperative learning condition were asked to claim a role or set of responsibility (i.e.,. recorder, super supporter, synergy guru and speed captain). Randomly, students were grouped into eight groups, which each group was consisted of the four roles. Students had to carried out their roles consistently throughout two-days experiment session. Separately, students in informal cooperative condition seated in the regular teaching position. However, the grouping (i.e.,. turn-to-your-partner) throughout the lecture were executed randomly (i.e.,. in the first halves of lecture, '*student on the right side will be your partner'*; on the second half on the lecture '*student who is seated behind you will be your partner*'). The overview of the study design was described as follows (see figure 1).

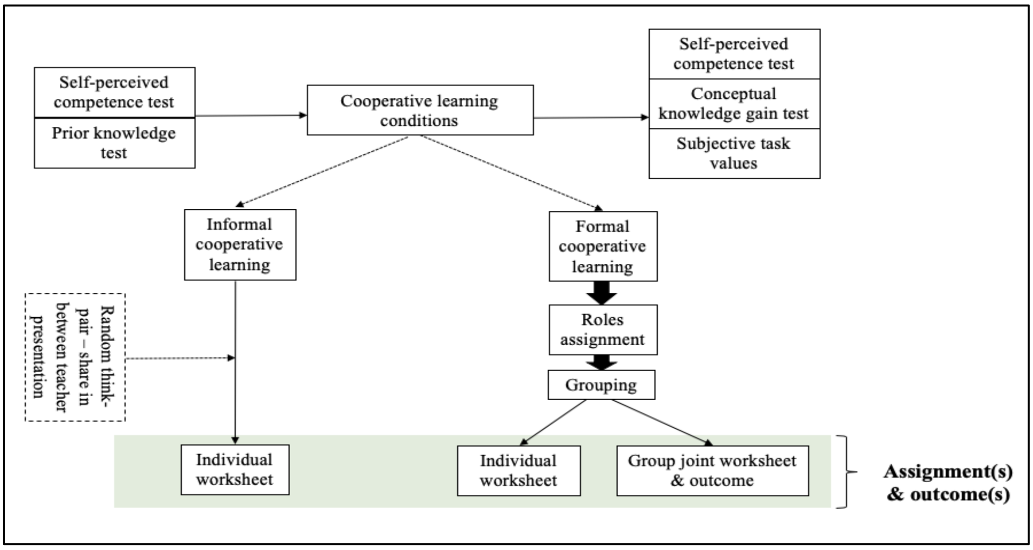

Figure 1 *Overview of the study design*

2. Method

2.1. Participants

The 72 participants (M_{age} = 12.94, *SD* = .84, ranging from 11 to 14 years) were eight-year junior high school students (*N* = 72) in two science classes in one Indonesian junior high school, of which 45 participants (63%) were female and 27 (37%) participants were male (see Table 1 for detailed information). In preparation, the researcher assigned the two existing science classes randomly (i.e., 8^{th} A and 8^{th} B; each classes *N* = 36) into two separated conditions; formal and informal cooperative learning. Formal cooperative learning group (*N* = 36) was divided randomly into nine small groups with four students in each group. On the other hand, informal cooperative learning group (*N* = 36) was operated in 18 discussion units, which each unit consisted of two students in each discussion phase before and after lecture with the closest in proximity partner randomly which started with tablemate or student at the front or the back.

Table 1

The descriptive statistics of participants' characteristics

	Cooperative learning conditions	
	Formal (N = 36)	Informal (N = 36)
Gender		
Female	24 (67 %)	21 (58 %)
Male	12 (33%)	15 (42 %)
Age		
M	13.06	12.83
SD	.75	.91

2.2. Design

A factorial design experiment was conducted to investigate and compare the difference between two cooperative learning conditions (i.e., formal and informal) on students' perceived competence and conceptual knowledge gain. The influence of roles assignment (i.e., *4S roles*) in formal cooperative learning condition towards students' perceived competence and conceptual knowledge gain was measured as well. This study also measured and compared the correlation between subjective task values towards students' perceived competence and conceptual knowledge gain between the two conditions. Assessments took place at before the implementation (T0) and one day after the implementation (T1).

2.3. Context of the study

In Indonesia, the required learning material and competencies were defined in the curriculum and obligatory for all students. The classroom activity that were expected by K-13 consisted of; observing, questioning, experimenting, associating and communicating (Ministry of Education and Culture, 2013) which can be facilitated through small group learning. At the time the research was executed, students had been taught mostly by the same science teacher adopting class presentation followed by individual practice procedure. However, the teacher indicated that students had obtained some experience by learning in small groups, as this setting was used in at least one (of six) lesson per week.

2.4. Materials

2.4.1. Learning tasks

In both conditions, learning content, background literature and learning objectives were identified and taken from the *'Buku Pegangan Siswa Kelas 8 Ilmu Pengetahuan Alam Kelas 8 Semester 2* (Indonesian standardized compulsory science book for eight-grade) with sub-topic *"convex and concave mirror"* (Zubaidah et al., 2017). The learning objectives were; (a) to describe the reflected image on the convex and concave mirror using scientific terminology, (b) to explain how reflection can be used in an everyday object, and (c) to implement the theory in a mathematical equation.

The most notable differences between the two conditions' learning task structure are the available information sources (i.e., multi-structural learning tasks in formal and teacher in informal condition), the use of an individual worksheet (for the visualization of individual worksheets in both conditions, see Appendix 2), and self-reflection. Regarding the latter, in the formal cooperative learning condition, students were encouraged to repeatedly reflect on their progress in grasping domain knowledge in each phase. Students were also encouraged to reflect their perspective towards the group process throughout phases. Meanwhile, in the informal cooperative learning condition, self-reflection was done only in the evaluation phase, which was depicting their general perspective towards their learning process and group dynamic (see Table 2).

<u>Formal cooperative learning tasks structure.</u> The learning tasks in formal cooperative learning group was comprised by three main phases; Introduction (four learning tasks), Experimentation (five learning tasks) and Evaluation (three learning tasks). The two main phases (i.e., introduction and experimentation) were executed at first intervention day, while the evaluation phase was executed at the second of intervention day. The visualization of the learning tasks can be seen on Appendix 3.

Introduction phase. The purpose was to inform students one and made students aware of their prior knowledge, the learning objective of the whole session, and to make them able to identify convex and concave mirror by using scientific terminology. This phase was consisted of four elements, as described below.

First, the prior knowledge of students was activated by an open question to indicate the level of students' knowledge (i.e., '*Do you know about the process image formation on a mirror? Discuss it together and write your answer!').* Second*,* the list of learning objectives were presented. Third*,* the first part of the information was presented to give students equal background knowledge. The key information for the curved mirror was containing, the illustration of shadow formation, with *'filling the blanks'* as the illustration description. To execute *'filling the blanks'*, students had to analyse and discuss the illustration together. This part was essential for the formal condition considering teacher was not the main source information. And fourth, in order to build students' background knowledge gradually, a *'match-making'* or *'guessing' game* was presented. Students had to identify the curved mirror characteristics into a certain type of curved mirror, then its application in daily life.

Table 2

The learning tasks comparison in formal and informal cooperative learning

Phase	Learning elements	Treatment group	
		FCL	ICL
Introduction phase	1	Activating Prior knowledge (IW)	
	2	Learning objective	Teacher Presentation
	3	Information Page	
	4	Match-making (IW)	Match-making
Experimentation phase	1	Prediction (IW) (GW)	Prediction (IW) (EX)
	2	Spoon experiment (IW) (GW)	Spoon experiment (IW) (EX)
	3	Reflection	-
	4	Information Page	Teacher Presentation
	5	Worked examples	
Evaluation phase	1	Group assignment (IW) (GW) (EX)	Focus discussion (GW)
	2	Group-reflection (GW) (IW)	-
	3	Self-reflection(IW) (GW)	Self-reflection (IW)

Note: formal cooperative learning group (FCL) and informal learning group (ICL); outcome measure; individual worksheet (IW); group worksheet (GW); and, externalisation or pitch presentation (EX).

Experimentation phase. This phase's purpose was to provide students with hands-on experience of convex and concave mirror reflection in everyday objects. Students were creating hypotheses, testing their hypotheses with an actual experiment, evaluating the synchronicity of their hypothesis and the result, and finally, evaluating the process. This phase consisted of three elements, as described below.

First, before the experimentation, research questions were presented (i.e., '*How do you think the reflection would be on different sides of the spoon? Would it be different?')* along with two pictures of the spoon. The group discussion was encouraged to predict the answer from the beforementioned research question. The keywords were provided to help students recognize the scientific terminology and, therefore, in answering the questions. Second, students were working on a small-scale experiment. Students had to adjust the distance of the object from curved mirrors (i.e., the inner and outer side of the spoon) and record the results of the observation. Furthermore, students had to answer two questions concerning the differences of the shadow formed on both sides of the spoon and providing arguments concerning the differences. The keywords were provided at the bottom of the page to help students in formulating the answers. Third, the students were evaluating the synchronicity between the past prediction and the actual results. The discrepancies were supposed to be addressed, along with the arguments. And fourth, students were informed about the application of the curved mirror in the form of a mathematical equation. Students were encouraged to seek help from the teacher, if they needed more prompts and supports regarding the material presented.

Evaluation phase. This phase was executed on the second day of the intervention. Students' understanding of the implementation of mathematical operations was evaluated utilizing group assignment and group presentation. The individual contribution (i.e., roles) within the group process and the group process itself were also evaluated. This phase consisted of three elements as described below.

First, the group was required to solve mathematical operation concerning curved mirrors and to create a ray diagram of shadow formation. Each group was encouraged to present their joint results and was asked to participate by comparing findings and giving questions. Second, group members were asked to reflect on the group satisfaction regarding their work (i.e., *How will your group rate your work?*). A reflection based on role involvement based on group members' appraisal was also added. And third, students' interdependence (i.e., group process value) and reflection-on-action (i.e., tasks utility values) were assessed.

Informal cooperative learning tasks structure. The task structure in informal cooperative learning condition was not as restrictive as the formal ones since it was not created as the primary source of knowledge construction but as a validation of students' attention and involvement in the classroom. Instead of using a *group worksheet,* the assignment was presented separately. This condition was comprised by three main phases; *introduction* (three learning tasks), *experimentation* (three learning tasks), and e*valuation* (one learning task). The two main phases (i.e., *introduction* and experimentation) were executed at the first intervention day, while the *evaluation* phase was executed at the second of intervention day. The visualization of the learning tasks can be seen in Appendix 4.

Introduction phase. This phase was aiming to inform and made students aware of their prior knowledge, the learning objective of the whole session and able to identify convex and concave mirror by using scientific terminology. This phase consisted of three elements as explained below.

The first part of the lecture was started with a brain storming session *(i.e., what do you know about concave and/or convex mirror? please indicate two words*). Students were required to write their answer on a piece of paper. A short presentation of their short discussion results was encouraged by pointing at four pairs randomly. After every short presentation, teacher asked question *(i.e.,. Do any of you share the same opinion? Why?)* which served as reflective support. Second, in contrast to the formal condition, the topic was explained through a regular teacher presentation. The amount of the information given through the teacher presentation was identical with the *information page 1* in formal cooperative learning's *introduction phase*. The confirmatory statements used in information page were substituted with direct question from the teacher towards the class (*i.e., Look at the picture. What will happen to the light once it hits the convex mirror? Where will they go*?). And third, the match-making task from the formal cooperative group will be used here with an additional question to confirm knowledge that students had gained from the match-making game.

Experimentation phase. The purpose of this phase was to provide hands-on experience of convex and concave mirror reflection in everyday object. In informal condition, reflection part was not added due to externalization in both prediction and experimentation. Externalization was enough to serve as an interpretative support and to check others understanding. Therefore, this phase was only consisted of three elements, as explained below.

First, the concept was identical to 'prediction page' in formal cooperative learning. However, to match the information exchange in formal cooperative learning, an externalization was required. The externalization was arranged randomly. Second, the concept of this part was also identical to the experimentation part in formal cooperative learning. Instead of four people in a group, the experimentation was executed in pairs. Students were required to discuss their main findings and teacher picked another four pairs randomly to externalized their ideas. And third, the teacher was presenting the same amount of information as ‘information page II' and ‘worked examples II'.

Evaluation phase. Students’ understanding of the implementation of mathematical operations was evaluated through an assignment. Despite being identical to the group assignment in formal cooperative learning group, the first half of the assignment (i.e., mathematical operation) was executed individually, while the last part of the assignment (i.e., ray diagram) was discussed in pairs.

2.4.2. Instruments

Self-perceived competence test. Students’ self-perceived competence were evaluated with *The Academic Self Description II* or *ASDQ II* instrument (Marsh, 1990, 1992). This instrument was designed for early adolescents, which is suitable for the age group that participated in the current study (i.e.,11-13 years old). The ASDQ II instrument contains of 136 items, classified into 17 scales which divided into four sub-scales, as follows.

Core subject matter was measuring students’ perceived competence towards nine core school subjects and comprised by nine subscales; English language, English literature, foreign languages, history, geography, commerce, computer studies, science, and mathematics. Each of the subscales had eight items.

Non-core subject was measuring students’ perceived competence towards nine non-core school subjects and comprised by six subscales; physical education, industrial art, art, music, religious studies, and health. Each of the subscales had eight items.

Self-concept subscale was measuring students’ non-academic perceived competence. This subscale had eight items.

General-school subscale was measuring students’ perceived competence toward their academic competence in general. This subscale had eight items.

Nevertheless, this study was focussed on the subject-related perceived competence in science, specifically physics which made not all of scales were relevant. Instead, for the current study the questionnaire was comprised by; two core subjects (i.e. science and physics), one *self-concept subscale* (i.e, physical) and one *general-school subscale* (i.e., school subjects).The subscales were tested in the pilot test of the study which involved 30 participants. The Cronbach alphas’ for each subscales was described as follows; *general school* (i.e., eight items,α = .78); *self-description* (i.e., seven items, α = .73), *science* (i.e., eight items,α = .88);

physics (i.e., eight items, α = .92), and in total contained 31 items (*Mdn* = .85). See Appendix 5 for the detailed visualization of the test.

Conceptual knowledge test. The conceptual knowledge test was consisted of four questions; one multiple choice question with three options (i.e., to examine students' knowledge in identifying curved mirror), three filling-the-blank or structured essay questions (i.e., to examine students' knowledge concerning the shadow formation in ray diagram for concave and convex mirror) and one essay question (i.e., to examine students' application in mathematical operation; see Appendix 6 for the entire test). The questions were extracted from various sources; multiple choice and filling the blanks (Zubaidah et al., 2017), structured essay questions (Wright, 2017), which was selected through the conformity with the learning goals. Throughout the experiment, one set of knowledge test was administered during before and after the intervention. The test was developed and pretested in pilot work with 30 junior high school students in the *SMP Negeri 3 Medan*.

The scoring process between each item was slightly different. For instance, the multiple choice question about the identification of curved mirror was awarded 1 point when answered correctly according to the answer key (see Appendix 7).

Item 2 (two) was fill-in-the-blank question. This item was divided into three sub-sections; 2a, 2b and 2c and were weighted differently. Item 2a was consisted of two -filling-the-blanks, which each correct answer was awarded one point (*Min* = 0, *Max* = 2). Item 2b was consisted of five -filling-the-blanks, which each correct answer was awarded one point (*Min* = 0, *Max* = 5). While, item 2c was consisted of five -filling-the-blanks, which each correct answer was awarded one point (*Min* = 0, *Max* = 5). In total, if item 2 was weighted as 12 points (*Min* = 0, *Max* = 12).

Lastly, item 3 was consisted of two essay question (i.e., a. to measure distance between image and mirror; b. to measure the magnification) where each correct answer was awarded one point (*Min* = 0, *Max* = 2). In total, entirely correct sub-items in item 3 was weighted as 2 points (*Min* = 0, *Max* = 2). Therefore, the full score of this test was 15 points. The Cronbach's alpha for this test was α = .58.

Qualitative input of subjective task values. Both of the conditions had evaluation phase, which one of the element from the activity was for students to fill in the self-reflection part in the individual worksheet. Students had to complete two open-ended questions to assess students' subjective task values which was divided into two specific parts; (1) *group process* *value* and (2) *task utility value*. Group process value was assessed to discover how students perceived the group dynamic which outcome was divided into positive (i.e., *the cooperation and discussion helped me in understanding the topic.*) or negative perspective (i.e., *it was hard to persuade my team to work together.*). On the other hand, *task utility value* was assessed to discover how students perceived the lesson in general to be useful for their educational goals in science lesson which outcome divided into positive (i.e., *I learned a lot, it was useful for my future studies.)* or negative outcome (i.e., *it was not beneficial for m*e.). Positive outcome was valued as +1, negative outcome was valued as -1 and non-related answer (i.e., '*blank'* or '*we learned to appreciate people opinion.')* was valued 0 in the equation. Therefore, *subjective tasks values* were derived by totalize *group process value* and *task utility value* (Min = -2, Max = +2).

2.5. Procedure

One day prior to the intervention, a briefing with teachers and the assistants was conducted to assure that the cooperative learning conditions would be executed accordingly. The briefing was intended to give further explanations about the cooperative learning conditions' procedure and assessment. A teaching manual which explained all of the learning activities, tasks materials, and time schedules was given to the teacher and assistant to make sure instructional steps mentioned in the manual were completed. The detailed explanation of learning activities and time allocation can be seen on Appendix 8.

2.5.1. Formal cooperative learning condition

The intervention was divided into two days. In the first intervention day, pre-tests for students' perceived competence and conceptual knowledge test were conducted and lasted for 30 minutes. After the pre-tests, teacher was explaining the classroom working condition and what kind of behaviour was expected in the cooperative learning condition. The teacher was announced the available roles and the contribution that was expected from these roles (i.e., *speed captain, super supporter, synergy guru, and recorder).* Then, students were choosing their roles based on personal preferences. To compose the group, each role was called separately by the teacher and labelled by certain number (i.e., one to nine). Everyone with the same number from different roles were grouped together and finally created nine small groups which each group was consisted by members with four different roles. Thereafter, the lecture was carried out in a fixed-group format for two days.

After the students had been seated in a group, learning tasks and materials in the form of group worksheets and individual worksheets were distributed. Learning activities (i.e., group-wise and individual) were scripted in the group worksheet and students were bound to complete the whole tasks and discuss all of the learning materials provided. The *introduction phase* was lasted for 32 minutes. After a 15 minutes break, the intervention was carried out to the *experimentation phase*. The *experimentation phase* was lasted for 91minutes. Throughout the whole separated learning phases, teacher was actively offering and providing support for students in need.

In the second intervention day, *evaluation phase* and *post-test* were conducted. The *evaluation phase* was lasted for 99 minutes. Students had to work on a three minutes short pitch presentation for each group and the non-presenter groups were encouraged to bring out additional ideas and questions based on their findings. The teacher was assessing the presentation and the learning outcome from each group and providing a written feedback which at the end of the lecture earned by each group. Afterward, students were encouraged to complete their reflection part in the group worksheets and individual worksheets. Students were welcomed to questioned teacher feedback on their group performance. Lastly, the *post-tests* for students' perceived competence and conceptual knowledge gain were administered to examine the effect of formal cooperative learning implementation. The tests was conducted for 30 minutes.

2.5.2. Informal cooperative learning condition

The intervention was divided into two days. In the first day, *pre-tests*, *introduction phase* and *experimentation phase* were conducted. While the second intervention day which held a day after the first intervention was comprised by an *evaluation phase* and *post-tests*.

The teacher was explaining the classroom working condition and what kind of behaviour was expected in the cooperative learning condition. Relative to the formal cooperative learning condition, neither tasks specialization nor roles assignment were used to shape their cooperative behaviour. Before the lecture began, *pre-tests* for students' perceived competence and conceptual knowledge test was executed for 30 minutes.

The introduction phase was started with a brainstorming session, the presentation of information and matchmaking games. The phase was lasted for 76 minutes. After a 15 minutes break, the lecture was proceed to the *experimentation phase* which was lasted for 62 minutes. The discussions throughout the lecture were arranged in *'pair-think-share'* format. In each of paired-discussion session, teacher was choosing pairs randomly to externalize their results and other pairs were invited to share their thoughts. The pair for each small learning tasks were different, students had to switch their partner (e.g., right side for first session, and later left side, back side, front side).

In the second intervention day, *evaluation phase* and *post-test* were conducted. The *evaluation phase* was lasted for 40 minutes. Students' understanding towards the application of mathematical equation of curved mirror was evaluated. Then, students exchanged their findings with the same *'pair-think-share'* format. Afterward, students had to conduct a *self-reflection* towards their learning progress in the individual worksheets and summed up the whole intervention. Lastly, *post-tests* for measuring students' perceived competence and conceptual knowledge gain were executed for 30 minutes.

3. Results

3.1 Descriptive statistic

This present study intended to compare the effects of formal and informal cooperative learning implementation on students' self-perceived competence and their conceptual knowledge. The differences in students' self-perceived competence and conceptual knowledge caused by the implementation of formal and informal cooperative learning would be discussed first. Then, to explore the effect of '4S roles' or task responsibility variation in formal cooperative learning groups towards students, the differences in self-perceived competence and conceptual knowledge gain were analyzed. Finally, to gain more insights on whether students' subjective appraisal towards the tasks given in the cooperative learning settings would influence their self-perceived competence and their performance on the conceptual knowledge test, a correlational measure was computed. Table 4 shows the pre-test and post-test mean scores of students' self-perceived competence and conceptual knowledge for formal and informal cooperative learning.

3.2 The effect of Cooperative learning conditions on self-perceived competence.

3.2.1. Formal cooperative learning condition

As shown in Table 3, the possible difference between students' perceived competence from the pre-test (M = 168, SD = 32.63) and post-test (M = 179.58, SD = 29.67) was investigated with a paired-sample t-test. The result revealed that the implementation of formal cooperative learning was significantly improving students perceived competence, which effect created by the implementation was substantial, $t(35) = -3.92$, $p = .00$; $r = .86$.

3.2.2. Informal cooperative learning condition

Table 3 indicates a possible difference between students' perceived competence from the pre-test (M = 158.50, SD = 24.49) and post-test (M = 161.19, SD = 27.80). The difference was investigated with a paired-sample t-test. The result reported that the implementation of informal cooperative learning was also significantly improving students perceived competence, which effect created by the implementation was substantial, t(35) = -1.27, p = .00; r = .89.

3.2.3. Differences between Cooperative learning conditions

Hypothesis 1 states that students in formal cooperative learning groups would estimate self-perceived competence more positively compared to students in informal cooperative learning group. To test this hypothesis, an independent-sample t-test was computed. The results show that the differences between students in formal cooperative learning group (M = 3.67, SE = 1.11) and informal cooperative learning group (M = 1.39, SE = 1.10) were not significant, t(70) = 1.45, p = .151; r = .17.

An analysis of variance was conducted to investigate the differences from two cooperative learning conditions on the sub-variables of self-perceived competence. The analysis revealed a significant mean difference between formal and informal cooperative learning group in sub-variable *'self-concept'* (F(1, 70) = 5.80, p = .02, ω = .36). No significant mean differences found on the other sub-variables : *'school subject'* (F(1, 70) = 2.18, p = .14, ω = .20), *'science'* (F(1, 70) = 1.15, p = .29, ω = .06) and *'physics'* (F(1, 70) = 2.11, p = .15, ω = .17).

3.3 The effect of Cooperative learning conditions on conceptual knowledge gain

3.3.1. Formal cooperative learning condition.

Table 3 indicates a possible difference between students' conceptual knowledge gain from the pre-test (M = 1.78, SD = 1.33) and post-test (M = 2.97, SD = 2.25). The difference was investigated with a paired-sample t-test. The result reported that formal cooperative learning was significantly supported students conceptual knowledge gain, which effect created by the implementation was moderately substantial, t(35) = -3.36, p = .02; r = .38.

Table 3

Descriptive statistic for self-perceived competence and conceptual knowledge for all students (n = 72).

	Formal Cooperative Learning (*n = 36)*		Informal Cooperative Learning (*n=36*)	
	M	SD	M	SD
Self-perceived competence				
Pre-test				
General school subject	44.75	8.50	43.36	5.77
Science	44.72	9.99	41.31	7.76
Self-concept	4.50	5.79	38.14	6.98
Physic	38.83	12.22	35.69	8.89
Total	168	32.63	158.50	24.49
Post-test				
General school subject	47.44	7.93	44.25	7.23
Science	46.61	8.61	41.86	8.57
Self-concept	43.03	5.83	38.00	7.50
Physic	42.50	11.55	37.08	8.95
Total	179.58	29.67	161.19	27.80
Conceptual Knowledge				
Pre-test				
Classification & categories	.53	.51	.75	.44
Principles & generalizations	1.39	1.64	1.56	1.03
Theories, Structures	.00	.00	.03	.17
Total	1.78	1.33	2.31	1.04
Post-test				
Classification & categories	.58	.500	.81	.40
Principles & generalizations	2.25	1.746	2.17	1.11
Theories, Structures	.00	.000	.03	.17
Total	2.97	2.25	2.97	1.06

3.3.2. Informal cooperative learning condition.

The possible differences between students' conceptual knowledge gain (see Table 3) from the pre-test ($M = 2.31$, $SD = 1.04$) and post-test ($M = 2.97$, $SD = 1.06$) was investigated with a paired-sample t-test. The result revealed that informal cooperative learning was significantly supported students conceptual knowledge gain, however effect created by the implementation was small, $t(35) = -1.72$, $p = .01$; $r = -.01$.

3.3.3. Differences between Cooperative learning conditions

Hypothesis 2 states that students in formal cooperative learning groups would perform better in conceptual knowledge test compared to students in informal cooperative learning group. To investigate this hypotheses, an independent-sample t-test was computed. The result indicates that the differences between students in formal cooperative learning group ($M = 1.19$, $SE = .36$) and informal cooperative learning group ($M = .67$, $SE = .25$) were not significant, $t(70) = 1.22$, $p = .23$; $r = .14$.

To gain more insights regarding the differences caused by the implementation of two cooperative learning conditions on the sub-variable level of conceptual knowledge, two independent sample t-test were computed. The analyses showed no significant difference between conditions on 'classification and category' ($t(70)=.00$, $p =1.00$) and 'principles & generalizations' ($t(70) = .55$, $p = .23$; $r = .06$).

3.4 Differences between assigned roles on self-perceived competence

Due to small sample size for each group of '4S roles' ($n < 10$); recorder ($n = 9$), super supporter ($n = 9$), synergy guru ($n = 9$) and speed captain ($n = 9$), non-parametric tests were used to examined the data (Siegel & Castellan, 1988). The detailed information can be seen in Table 4.

Hypothesis 3 states roles assigned (i.e.,*4* roles) in formal cooperative learning would influence students to obtain differences in self-perceived competence. A Kruskal-Wallis test was computed to investigate this hypothesis. The result revealed that students' self-perceived competence was not affected by roles or task responsibility variations, ($H(3) = 2.81$, $p = .42$). Six Mann–Whitney tests were used to follow up this finding. Bonferroni correction was applied and so all effects are reported at a .01 level of significance. Yet, the pairwise comparisons between roles revealed no significant difference in self-perceived competence.

Students' self-perceived competence differences on a sub-variable level (i.e., school subject, self-concept, science and physics) were assessed for every task responsibility variations or '4S roles' separately by means of post-test and pre-test score differences using four Kruskal-Wallis tests. The analyses revealed no significant differences among roles or task responsibility variations for sub-variables; *'school-subject'* ($H(3) = 3.91$, $p = .27$), *'science'* ($H(3) = 2.81$, $p = .42$), '*self-concept'* ($H(3) = 1.06$, $p = .79$) and *'physics'* ($H(3) = 3.92$, $p = .27$).

Table 4

Descriptive statistic for self-perceived competence for all '4S roles' in formal cooperative learning group (N = 36)

	Recorder (*n = 9)*		Super supporter (*n=9*)		Synergy Guru (*n=9*)		Speed Captain (*n=9*)	
	M	SD	M	SD	M	SD	M	SD
Self-perceived competence								
Pre-test								
General school subject	41.11	7.36	48.44	8.05	48.33	5.90	41.11	10.11
Science	41.89	10.43	49.67	7.37	46.11	9.68	41.22	11.27
Self-concept	38.44	5.66	41.00	8.44	41.78	3.87	40.78	4.66
Physic	42.22	11.01	47.33	11.87	43.67	9.96	36.78	12.57
Total	156.7	31.26	182.9	33.90	177.9	23.7	157.6	36.68
Post-test								
General school subject	45.33	7.97	48.89	9.10	50.33	5.17	45.22	8.94
Science	46.11	8.19	49.78	6.92	48.89	6.31	41.67	11.15
Self-concept	42.33	4.58	43.67	7.05	44.56	4.04	41.56	7.45
Physic	42.22	11.01	47.33	11.86	43.67	9.96	36.78	12.57
Total	176.0	29.55	189.7	32.16	187.4	19.85	165.22	33.46

3.5 Differences between assigned roles on conceptual knowledge gain

Hypothesis 4 states that the four roles assigned in the formal cooperative learning condition would influence students to perform differently in conceptual knowledge test. A Kruskal-Wallis test was computed to test this hypothesis. The detailed score between each roles can be seen in Table 5. The result revealed that was no significant differences created by the roles assigned on conceptual knowledge gain, $H(3) = 2.86$, $p = .42$. Therefore, students' conceptual knowledge gain was not affected by roles or specific responsibility assigned. To gain more insights into comparisons among roles, six Mann–Whitney tests were used to follow up this finding. Bonferroni correction was applied and all effects are reported at a .01 level of significance. The pairwise comparisons between roles revealed no significant differences in conceptual knowledge gain.

Table 5

Descriptive statistic for conceptual knowledge test for '4S roles' in formal cooperative learning group (N = 36)

	Recorder (*n* = 9)		Super supporter (*n*=9)		Synergy Guru (*n*=9)		Speed Captain (*n*=9)	
	M	SD	M	SD	M	SD	M	SD
Conceptual Knowledge								
Pre-test								
Classification & categories	.33	.50	.78	.44	.44	.53	.56	.53
Principles & generalizations	.89	.93	1.89	2.52	1.44	1.24	1.33	1.58
Total	1.33	.71	2.00	1.23	1.89	1.27	1.89	1.97
Post-test								
Classification & categories	.33	.50	.67	.50	.78	.44	.56	.53
Principles & generalizations	1.56	.73	2.78	1.79	1.89	.93	2.78	2.73
Total	1.78	1.09	4.22	2.59	2.56	1.13	3.33	3.04

Students' conceptual knowledge gain in sub-variable level (classifications and categorizations; and principles and generalizations) were assessed for every task responsibility variations or '4S roles' separately using two Kruskal-Wallis tests. The analyses revealed no significant differences among roles or task responsibility variation for sub-variables; *'classifications and categorizations'* ($H(3) = 3.05$, $p = .38$), also *'principles and generalizations'* ($H(3) = 1.61$, $p = .67$).

3.6 Differences between cooperative learning conditions on subjective task value

Hypothesis 5 states that students in formal cooperative learning would appraise task value more positively (expressed by positive or negative statements in the individual worksheet) than would students in informal cooperative learning. To test this hypothesis an Independent sample t-test was computed. The result (see Table 6) shows that students' in formal cooperative learning group (*M* = .78, *SD* = .35) perceived task value more positively compared to students' in informal cooperative learning group (*M* = .42, *SD* = .55), $t(70) = 3.31$, $p = .001$, $d = 0.78$.

Subjective task value was comprises from *task utility value* and *group process value*. To gain more insights whether cooperative learning conditions might influence the way students perceived both mentioned sub-variable, two independent sample t-test were computed. The analysis for *task utility value* revealed no significant differences in formal cooperative learning group and informal cooperative learning group, $t(70) = 1.33$, $p = .19$, $d = 0.30$. However, the analysis for *group process value* revealed otherwise, that students in formal cooperative learning group perceived group process value more positively compared to students in informal cooperative learning group, $t(70) = 5.63$, $p = .00$, $d = 1.32$.

Table 6

Descriptive statistic for subjective task value for all students (n = 72)

	Formal Cooperative Learning (*n = 36)*		Informal Cooperative Learning (*n=36*)	
	M	SD	M	SD
Subjective Task Value	.78	.35	.42	.55
Task Utility Value	.58	.65	.36	.76
Group Process Value	.97	.17	.47	.51

3.7 Relations between students' subjective task value on self-perceived competence and conceptual knowledge gain.

Hypothesis 7 states that students' appraisal of *task utility value* and *group process value* would influence their self-perceived competence and conceptual knowledge gain. To investigate this hypothesis, a correlational analysis was computed. Table 7 shows that students' appraisal to *group process* was positively associated with their *self-perceived competence* (i.e., higher mean score difference between pre and post measurements) and their appraisal to the task utility value. However, the result also displayed that students' conceptual knowledge gain was not influenced by students' appraisal towards the group process, task utility value, and students' perceived academic competence.

Table 7

General correlational matrix (for all students)

		1	2	3	4
1	Conceptual knowledge test	---			
2	Academic self concept	.10	----		
3	Task utility value	.04	.07	---	
4	Group process value	.10	.37**	.41**	---

**. Correlation is significant at the 0.01 level (2-tailed).

To gain more insights regarding the influence of different cooperative learning groups arrangement on students' subjective tasks value and its relation towards their results on conceptual knowledge and self-perceived competence test, separate correlational analyses were conducted for the two cooperative learning conditions (see Table 8).

The correlational analysis for *Formal cooperative learning group* shows that students' appraisal towards group process was positively associated with students' perception towards their academic competence in the subject. However, the influence from the group process was not associated with their perception of the task utility value) and in turn also reflected in their pre-test to post-test conceptual knowledge gain.

The analysis for *Informal cooperative learning group* shows that students' appraisal towards group process was positively correlated with their perception for the task utility value. The conceptual knowledge gain and students' self-perceived competence were not positively related to students' appraisal towards group process and their perceived academic competence.

Table 8

Correlation matrix for the conditions separately

			Informal cooperative learning			
			1	2	3	4
Formal cooperative learning	1	Conceptual knowledge test	---	-.018	-.168	.063
	2	Self-perceived competence	.103	---	.026	.298
	3	Task utility value	.163	.037	---	.508**
	4	Group process value	-.065	.423*	.154	---

Note: The correlations of the formal condition are shown on the left, the correlations of the informal condition are shown on the right.

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

4. Discussion

The primary aim of this present study was to explore the difference between formal and informal cooperative learning implementation on students' self-perceived competence and conceptual knowledge. The second aim was to gain more insights regarding how '*4S roles'* or *task responsibility variation* influenced students' perceived competence and conceptual knowledge gain. Lastly, this study was aiming to investigate whether students' subjective appraisal towards the tasks given in the cooperative learning settings influenced their self-perceived competence and their performance on the conceptual knowledge test.

4.1. The effect on self- perceived competence

The findings showed that the implementation of both cooperative learning were significantly improved students' perceived competence, however no significant differences found between formal and informal cooperative learning on students' perceived competence. This finding contrasts to the previous studies which indicated that students in high-structure cooperative learning condition developed stronger sense in motivational engagement, attitude towards learning activities of confidence in their subject-specific competence (Johnson & Johnson, 1989; Kyndt et al., 2013; Slavin, 1995). Yet, the finding from this study indicated indifference between the two cooperative learning conditions in subject-related competence (i.e., *science* and *physics*). On the other hand, a substantial difference between the two condition was found on *'self-concept'* element, formal cooperative learning group was significantly bested informal cooperative learning.

Notably, there were no substantial differences on self-perceived competence between the two cooperative learning conditions. One factor would be, students in informal cooperative learning condition were not receiving any feedback thus overestimating their knowledge (see Supanc et al., 2017 pp. 81) Otherwise, students in formal cooperative learning received extensive feedbacks from team members and teacher which either caused them to downplayed their knowledge or remained real with their level of knowledge. Another factor could be that the highly-structured cooperative learning condition made students feel less autonomous (Berger & Hänze, 2009). The less autonomy was fostered by the lack of acknowledgement in students' perspective, lack of opportunity for initiative and the lack of appreciation for choices (Deci, Eghrari, Patrick, & Leone, 1994; Deci & Ryan, 1985; Ryan, 1982). For instance, the phenomena of '*confirmation bias'* (Nickerson, 1998), which found to be detrimental in a collaborative learning setting.

Another interesting finding might be the substantial score difference of '*self -concept'* caused by the implementation of formal cooperative learning. The finding might be caused by the successful attempt at learning tasks and the internalization of group rewards which led to a boost of students' self-concept (Nastasi & Clements, 1991). The result was acceptable considering the existence of three reflective support (i.e. group, teacher, and continual note on individual worksheet). On the other hand, informal cooperative learning only have one reflective support (i.e., individual worksheet) and no group rewards, thus the non-existence of external forces could meddling with their self-worth throughout the session.

Hence, these findings might explain the reason of unsubstantial differences between the two conditions despite the structure in formal cooperative learning condition which designed to highlight individual accountability and members' interdependence

4.2. The effect on conceptual knowledge

The implementation of both cooperative learning conditions were significantly contributed in students' conceptual knowledge gain. Yet, no significant differences were discovered between the two cooperative learning conditions. It was also found that students in informal cooperative learning group (M= .03) was slightly outperformed students in formal cooperative learning group (M = .00) in the conceptual knowledge test's most cognitively demanding item. Likewise, Weldon and Bellinger (1997) reported that collaborative groups recall significantly less than nominal groups. The first explanation could be a *'collaborative inhibition'* phenomenon, when people remembering together recall less than if they remember separately (Kirschner et al., 2009a; Kirschner, Paas, & Kirschner, 2009b). The possibility to be cognitively invested in transactional activity (e.g., discussing ways to share information) can be either beneficial or detrimental for learning.

Interestingly, this finding was contrasted to the findings of earlier studies which claimed that higher-structured cooperative learning would performed better knowledge gain (Archer-Kath et al., 1994; Slavin, 1995). While another studies were conceded to the finding in this study. Springer, Stanne and Donovan (1999) compared studies with highly-structured cooperative learning methods (8 studies) to studies with less-structured cooperative learning methods (7 studies). The analysis of achievement outcomes revealed no substantial differences between these two methods (ES = 0.56 vs 0.52). Even though high-structured cooperative learning was superior, assuming that structure helped to reduce cognitive load to manageable levels and thereby facilitates deeper understanding (Webb, 1982). But, students still had to process a large amount of domain knowledge. Specifically, when all of the students were novices in curved mirror.

Another probable reason behind the result could be that students might need more time to digest the information. The knowledge gain test was held just a day after the whole procedure of cooperative learning conditions (i.e., included the feedback session in the same day) which might not be the most sufficient time, considering the possibility of students needed more time to assimilate and comport the yesterday's large amount of domain knowledge. For instance, Cepeda, Pashler, Vul, Wixted, and Rohrer (2006) considered the effect of retention interval (i.e., time between the last study session and testing), the lengths of the inter-study interval (i.e. time between study sessions) and test performance, which the longer retention intervals requiring longer inter-study intervals for the superlative effect.

4.3. Assigned roles on students' perceived competence and conceptual knowledge gain.

The result revealed that students' self-perceived competence was not affected by roles. The probable reason might be that the roles assigned was succeed in creating an equal working condition in which every team member felt equal sense in motivational engagement. This circumstance might resulting a positive attitude towards learning activities and confidence or subject-specific competence (Johnson & Johnson, 1989; Kyndt et al., 2013; Slavin, 1995).

Separately, The result also indicated no significant differences created by the assigned roles on conceptual knowledge gain. Therefore, students' conceptual knowledge gain was not affected by roles or specific responsibility assigned. The result was intriguing, considering someone who wrote the last information as supposedly benefitted to gain more information than the rest of the team member (i.e., *recorder*). But as explained in the previous chapter (see. 4.2), on *'why does informal cooperative group can out-performed the formal cooperative group'* that perhaps more time and measurement are needed. Particularly, in accordance of the previous argument on *'whether recorder can out-performed another team members'*, that *'recorder'* might need more time to digest the information.

4.4. Subjective tasks values

Relative to informal cooperative group, the implementation of formal cooperative group had positive impacts on how students perceived their learning tasks (i.e., *subjective tasks* value). Students in formal cooperative learning also perceived *'group process'* more positively than students in informal cooperative group, no distinguished for ask utility value.

A correlational analysis revealed that how students in formal cooperative learning perceived their group process was positively correlated to their perceived competence. This finding was expected, in respect of tasks interdependence and resource interdependence as core elements in formal cooperative learning which promote cooperative behaviour in the group, interrelatedness between group and individual achievement (Johnson & Johnson, 2002), which also explained the reason why students in formal cooperative learning perceived group process more positively.

5. Limitation And Implication

The limitations of this study should be acknowledged. Firstly, this study was only investigating the effect created after a single session of formal and informal cooperative learning, with randomization was took place in nested classes and without further deliberation on class size differences. However, instead of intact or nested classes, liberty to fully assign individual students towards conditions would give further illustrations on whether the social preferences would affect students' cooperative behavioral tendencies. Moreover, to what extent it might influence students' appraisal towards group process and hereafter affecting students' perceived competence. An opportunity to test out more conditions (i.e., jigsaw as a comparison) into more classes, to see whether prior experience in cooperative learning might determine the cooperative behavioral tendencies throughout the session would be beneficial as well.

Secondly, this study did not include past proof of students' achievement (i.e., subject-related academic achievement) and pre-measure student's school engagement as predictor values. For the future study, the values mentioned above are potentially beneficial in order to gain more wholesome insights on why a specific structure might or might not affect students' perceived competence and conceptual knowledge gain.

Thirdly, further research is needed to determine whether formal or more structured cooperative learning makes students more likely to apply their acquired knowledge and increases their involvement in the regular class setting. A retention test after at least a month from the last intervention would be beneficial to measure the 'incubation effect'. More implementation of cooperative learning also needed to investigate the progression of students' cooperative behavior. The tendency of students to arrange their group-work and their dependency on external prompt after being more familiar to cooperative learning would be interesting to explore.

Fourth, further research is needed to scrutinize the sufficiency of the two cooperative learning conditions across different group of participants. For instance, between students with high-medium-low level of subject related-perceived competence, or across ability level. In addition, whether a highly-structured cooperative learning could be detrimental or contrariwise beneficial towards learning on enthusiastic-student or low achiever student would be interesting to investigate.

Fifth, factors that might influence the students' willingness to work collaboratively (e.g. students' proficiency in teamwork, social preferences) were not taken into account in this study. For instance, formal groups appraised group process more positively compared to the informal group, but whether the accentuation on mutual-interdependence produces social pressure and evoked interpersonal conflict within the group was not overlook. De Dreu and Weingart (2003) argued that the different argument in group might not be seen as a difference in the interpretation of the problem but as a personal, emotional rejection and as such can interfere with productive team behaviour. Further research is needed to analyze group resolution and its interaction towards perceived competence and group performance, then how it would affect individual performance.

Sixth, current analysis did not address the issue, whether students' perspective towards science and their expectation to pursue more science-focussed education would affect their functioning in the group. Therefore, affecting their perceived knowledge gain and the process of generating a more *'transactive'* form of communication in cooperative learning setting (Berkowitz & Gibbs, 1983).

6. Conclusions

Despite the limitation abovementioned, this study shows that the implementation of formal and informal cooperative learning are both beneficial to solidify a sense of competence and supportive to conceptual knowledge acquisition. However, the lack of significant differences elicited between the two cooperative learning condition shows equal sufficiency as learning strategy which the appropriation of the two conditions should be aligned with teacher condition, learning content and time constraint.

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Appendices

Appendix 1

The overview of structure differences between formal and informal cooperative learning

	Formal Cooperative learning	Informal Cooperative learning
Pre-organization of group work		
- Group goals	+	+
- Assigned roles	+	
- Tasks specialization	+	
- Prompts of self-reflection	+	+
Focus of instruction		
- Student-centred	+	
- Teacher-centred		+
Outcome		
- Joint outcome	+	
- individual outcome	+	+
Feedback		
- Group feedback to the member	+	
- Other group feedback to the group	+	+
- Teacher feedback to the group	+	

Appendix 2
Individual worksheets

Formal cooperative learning (In Indonesian)
Page 1.

Nama :	Peran di dalam kelompok : ○ speed captain ○ super supporter ○ synergy guru ○ recorder

Mengaktifkan pengetahuan masa lalu ---1

1. Apa yang kamu ketahui tentang cermin lengkung ? ____________________

Menurut kelompok saya : ____________________

Pilih salah satu dari pernyataan ini : ○ Saya setuju dengan pendapat kelompok saya, karena ____________________
○ Saya tidak setuju dengan pendapat kelompok saya, karena ____________________

Halaman informasi : Kesimpulan Pribadi ---2

2. Seberapa baik Anda memahami topik yang disajikan? (**gunakan kata kunci; cermin cembung, cermin cekung, bias cahaya, cahaya masuk!)**
____

Halaman Prediksi : Prediksiku ---- 4

3. Apa kesimpulan meja / tim Anda ? ____________________

Bagaimana menurutmu ?
a. Sisi dalam sendok : menurutku ____________________
b. Sisi luar sendok : menurutku ____________________

Halaman refleksi : Versiku----6

4. Apa perbedaan utama dari bentuk bayangan pada kedua sisi sendok ? mengapa bisa berbeda ?____________________

Apa kesimpulan meja / tim Anda ? ____________________
Apakah Anda setuju dengan kesimpulan tim ? (pilih satu dan jelaskan).
a. ya, karena ____________________
b. Tidak, karena

Page 2.

5. Apakah prediksi dan hasil pengamatanmu sesuai ?
a. ya, karena ____________________
b. Tidak, karena ____________________

Bagaimana menurutmu ……..

1) Apa yang sudah kamu pelajari hari ini? Saya belajar____________________

2) Apa yang bisa saya lakukan hari ini?____________________

3) Apakah menurut Anda pengalaman belajar hari ini bermanfaat bagi Anda? (pilih pilihan dan tunjukkan alasan Anda)
a. Ya, karena ____________________
b. Tidak, karena ____________________

4) apakah kamu setuju dengan pandngan kelompokmu terhadap kontribusimu dalam kelompok ?
a. Ya, karena ____________________
b. Tidak, karena ____________________

5) apakah kamu puas dengan konribusimu didalam kelompok ?
a. Ya, karena ____________________
b. Tidak, karena ____________________

Informal cooperative learning (In Indonesian)

Nama :	Nama pasangan fase 1: ____ , fase 2 : ____ , fase 3: _____

Mengaktifkan pengetahuan masa lalu ---1

1. Beri saya dua kata, tentang cermin melengkung ! _______ _______ , tanyakan pada rekan Anda apa yang dia pikirkan tentang hal itu !!

   Kesimpulan grup Anda : ________ _________ dibandingkan dengan kesimpulan grup lain :_______ ________

Halaman informasi : Kesimpulan Pribadi ---2

2. Seberapa baik Anda memahami topik yang disajikan? (**gunakan kata kunci; cermin cembung, cermin cekung, bias cahaya, cahaya masuk!)**

____

____

Halaman Prediksi : Prediksiku ---- 5

3. Prediksi sendok

a. Sisi dalam sendok : menurutku ____

b. Sisi luar sendok : menurutku ____

Tanyakan pada rekan sekelompokmu apa yang kamu pikirkan tentang hal itu !! Apa kesimpulan meja / tim mu? ______________________________________

Pengamatanku : Sendok ---4

4. kesimpulan pengamatan Anda : ____

   ____

5. Apakah Anda setuju dengan kesimpulan tim ? (pilih satu dan jelaskan).

   a. ya, karena ____

   b. Tidak, karena ____

Bagaimana menurutku ……..

6. Apa yang sudah kamu pelajari hari ini? Saya belajar____
7. Apa yang bisa saya lakukan hari ini?____ ________
8. Apakah menurut Anda pengalaman belajar hari ini bermanfaat bagi Anda? (pilih pilihan dan tunjukkan alasan Anda)

   a. Ya, karena ____

   b. Tidak, karena ____

Appendix 4

Formal cooperative learning tasks overview

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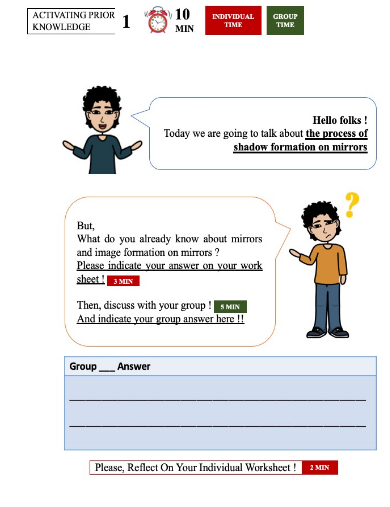
<tr><th>Prior Knowledge Page</th><th>Learning Objective Page</th><th>Information Page I</th></tr>
<tr>
<td>
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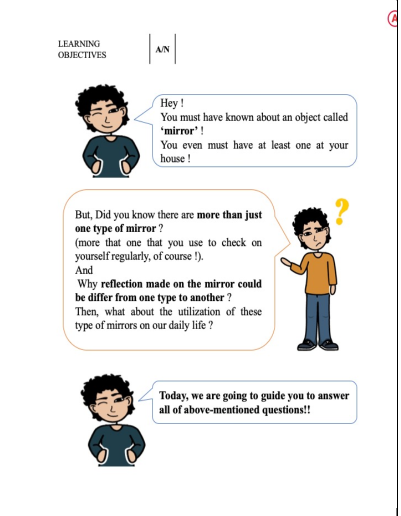
<td>
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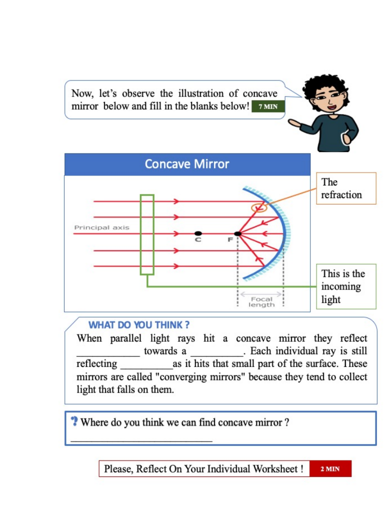
<td>
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<tr><th>Match-Making Page</th><th colspan="2">Prediction Page</th></tr>
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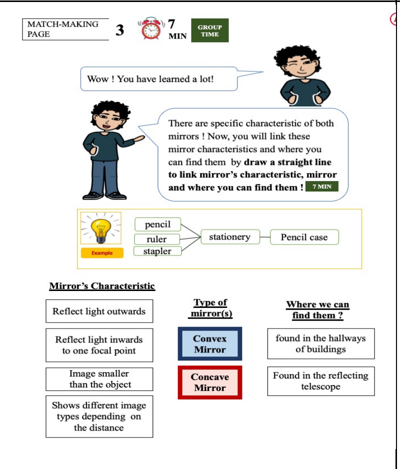
<td>
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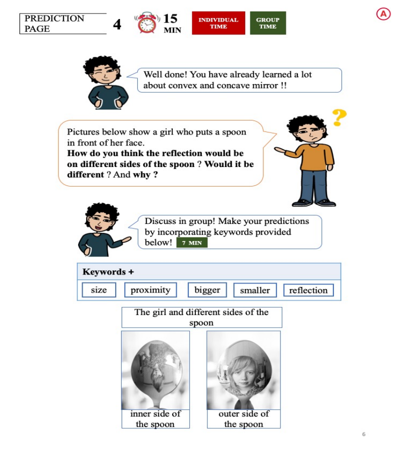
<td>
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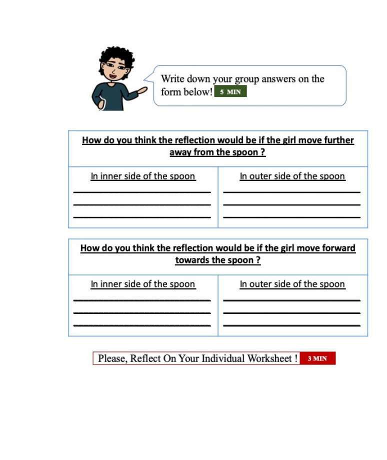
<td>
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<tr><th colspan="2">Experimentation Page</th><th>Reflection Page</th></tr>
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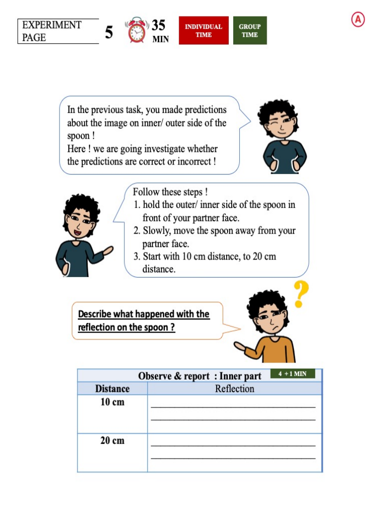
<td>
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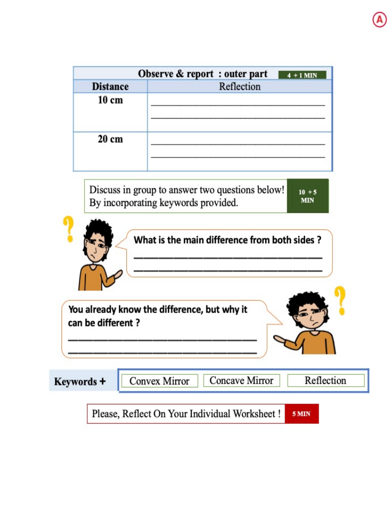
<td>
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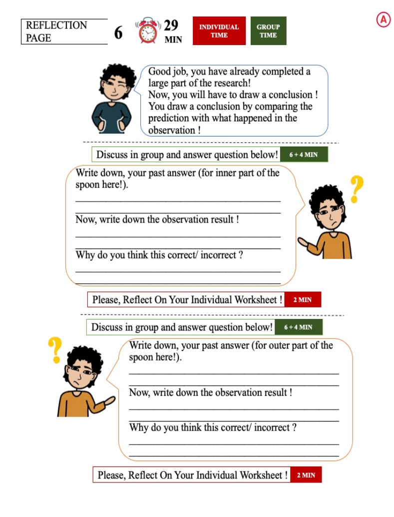
<td>
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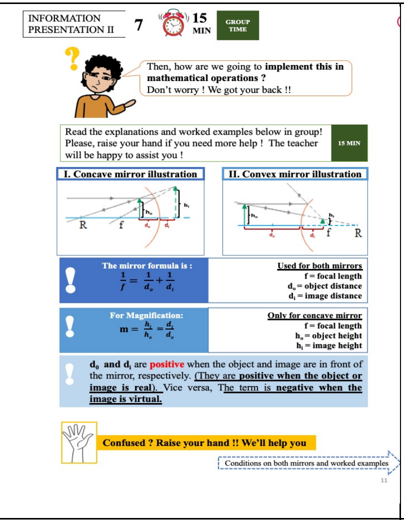
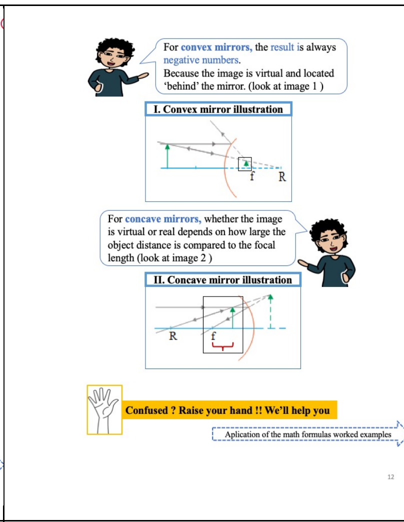
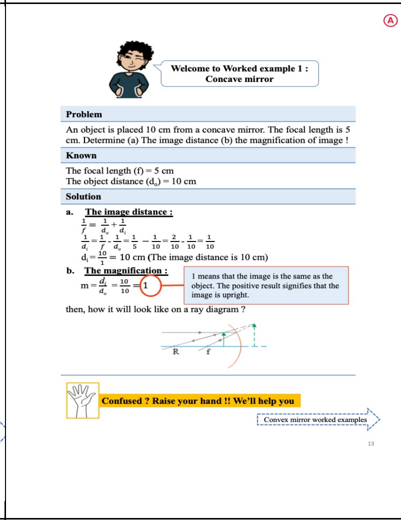
Information page II

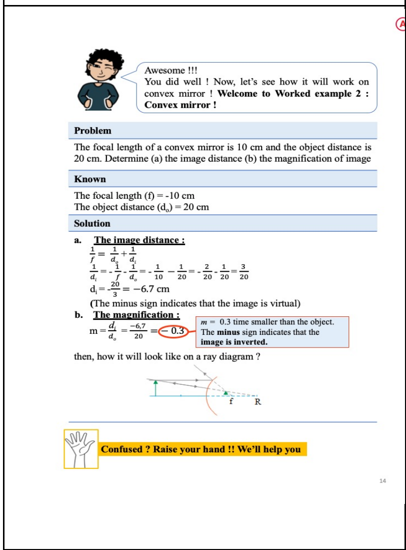




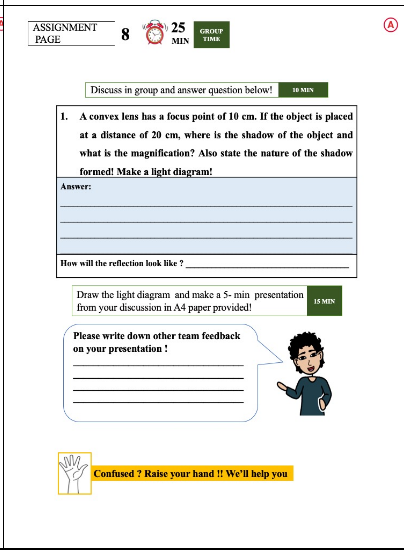
Worked example 1



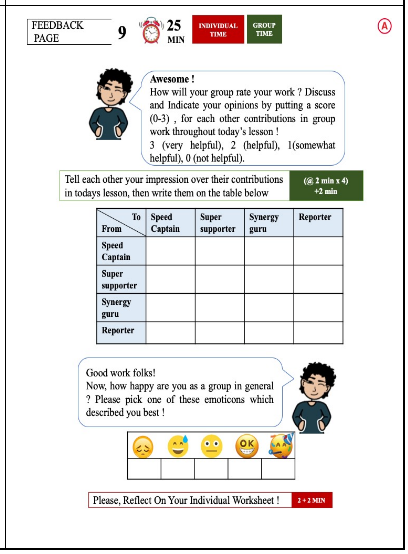
Worked example 1



Assignment



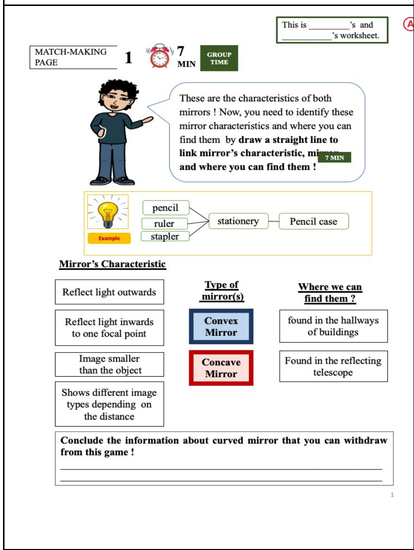
Group Evaluation



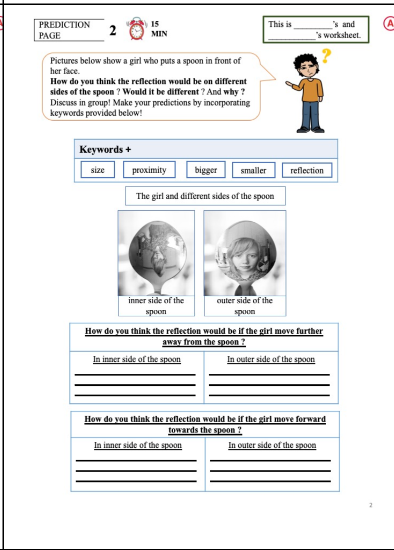
Appendix 5

Informal cooperative learning tasks overview

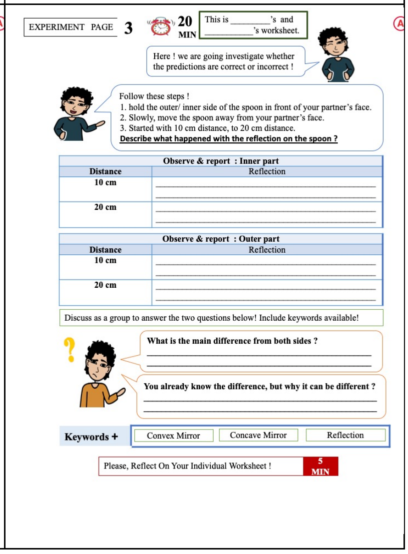
Match-making page



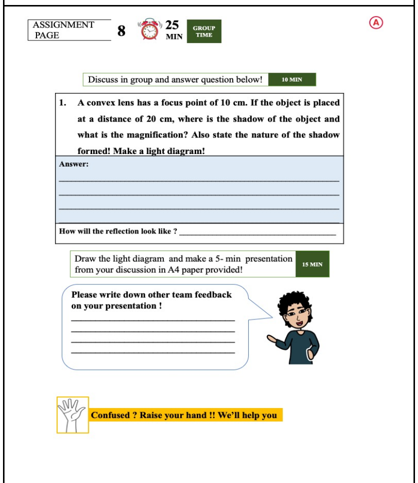
Prediction page



Experiment page



Assignment page



Appendix 6

Self-perceived competence questionnaire (ASDQ II)

ASDQ II©

INSTRUMEN

All information supplied will be kept strictly confidential									

NAME :	**AGE: (years) (mths)**		**DATE : / / /**
MALE /FEMALE (circle one)	**PROGRAM :**		**GROUP :**

PLEASE READ THESE INSTRUCTIONS FIRST

This is not a test - there are no right or wrong answers.

Your answers are confidential and will only be used for research or program development. Your answers will not be used in any way to refer to you as an individual.

This is a chance for you to look at how you think and feel about yourself. It is important that you are honest and that you give your own views about yourself, without talking to others.

On the following pages are a series of statements that are more or less true (or more or less false) descriptions of you. Please use the following eight-point response scale to indicate how true (or false) each item is as a description of you. Respond to the items as you now feel even if you felt differently at some other time in your life. In a few instances, an item may no longer be appropriate to you, though it was at an earlier period of your life (e.g., an item about your present relationship with your parents if they are no longer alive). In such cases, respond to the item as you would have when it was appropriate.

After completing all the items, you will be asked to select those that best describe important aspects – either positive or negative – of how you feel about yourself. Consider this as you are completing the survey.

Use the following eight-point scale to indicate how true (like you) or how false (unlike you), each statement over the page is as a description of you. Please do not leave any statements blank

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Definitely False	Mostly False	False	More false than true	More true than false	Mostly true	true	Definitely True

	Statement	False							True
		1	2	3	4	5	6	7	8
1.	I have always done well in most school subjects								
2.	Overall I have a lot to be proud of								
3.	Work in **Science** classes is easy for me								
4.	I am hopeless when it comes to most school subjects								
5.	I have always done well in **Physics** classes								
6.	I am satisfied with how well I do in most school subjects								
7.	Its important for me to do well in **Science** classes								
8.	I have always done well in Science classes								
9.	Compared to others my age I am good at most school subjects								
10.	Overall I am a failure								
11.	I get good marks in **Physics** classes								
12.	I am satisfied with how well I do in **Physics** classes								
13.	I learn things quickly in **Science** classes								

14.	I learn things quickly in most school subjects								
15.	I am satisfied with how well I do in Science classes.								
16.	Compared to others my age I am good at **Physics** classes								
17.	I am hopeless when it comes to **Science** classes.								
18.	Most things I do, I do well								
19.	I feel that my life is not very useful								
20.	I learn things quickly in **Physics** classes								
21.	It’s important for me to do well in **Physics** classes								
22.	I can do things as well as most people								
23.	Work in **Physics** classes is easy for me								
24.	Compared to others my age I am good at **Science** classes.								
25.	I am hopeless when it comes to **Physics** classes								
26.	Its important for me to do well in most school subjects								
27.	I get good marks in **Science** classes								
28.	Most things I do, turn out well								
29.	I don’t have much to be proud of								
30.	Work in most school subjects is easy for me								
31.	I get good marks in most school subjects								

Appendix 7

Knowledge test

KNOWLEDGE TEST

All information supplied will be kept strictly confidential									

NAME :	**AGE: (years) (mths)**	**DATE : / / /**
MALE /FEMALE (circle one)	**PROGRAM :**	**GROUP :**

PLEASE READ THESE INSTRUCTIONS FIRST

This is not a test - there are no right or wrong answers.

Your answers are confidential and will only be used for research or program development. Your answers will not be used in any way to refer to you as an individual.

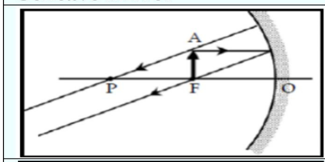
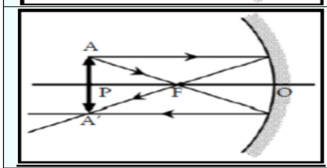
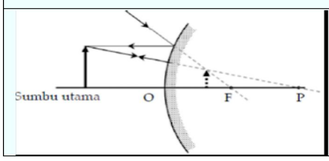
1. **Choose the explanation below which is the most correct combination of mirror characteristics and mirror applications in everyday life!**

   a. Concave mirrors reflect the light out. That was the reason why concave mirrors show different types of shadows depending on distance. This mirror is often found as a reflecting mirror in a parking lot.

   b. The convex mirror reflects the light out so that it shows different types of shadows depending on the distance. This mirror is often found as a reflecting mirror in a parking lot.

   c. Concave mirrors reflect the light out so that they show different types of shadows depending on distance. This mirror used as sun collector at solar power plant.

2. Fill in the blanks below based on the information you have got from the visual illustration!

Concave mirror	
	If the object is placed on ________ will form a shadow at____________.
	If the object is placed on ______________. The shadow that is formed will look, ______, ________ and _______. The shadow will be placed at the _______of the mirror.
Convex mirror	
	If the object shadow on a convex mirror is always between the points, ____ and_____. The nature of the shadow produced by a convex mirror are________, _______, and __________.

3. A baby was playing within 100 cm Focal length 50 cm in front of a concave mirror. Determine;
   (a) the distance of the shadow (b) the magnification of the shadow.

The math-equation of curved mirror.	The math-equation of curved mirror.
$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$	$m = \frac{h_i}{h_o} = \frac{d_i}{d_o}$

Appendix 8

Knowledge test – the answer

KNOWLEDGE TEST

All information supplied will be kept strictly confidential										

NAME :	AGE: (years) (mths)	DATE : / / /
MALE /FEMALE (circle one)	PROGRAM :	GROUP :

PLEASE READ THESE INSTRUCTIONS FIRST

This is not a test - there are no right or wrong answers.

Your answers are confidential and will only be used for research or program development. Your answers will not be used in any way to refer to you as an individual.

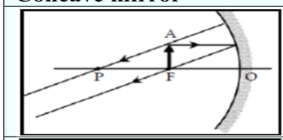
1. **Choose the explanation below which is the most correct combination of mirror characteristics and mirror applications in everyday life!** **Point : 1**
   a. Concave mirrors reflect the light out. That was the reason why concave mirrors show different types of shadows depending on distance. This mirror is often found as a reflecting mirror in a parking lot.

   b. The convex mirror reflects the light out so that it shows different types of shadows depending on the distance. This mirror is often found as a reflecting mirror in a parking lot.

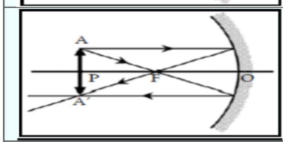
   c. Concave mirrors reflect the light out so that they show different types of shadows depending on distance. This mirror used as sun collector at solar power plant.

2. **Fill in the blanks below based on the information you have got from the visual illustration!**
   Point : 12

Concave mirror

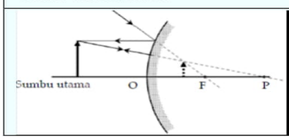


2a → Point : 2
If the object is placed on **focus point (f)** will form a shadow at **infinite distance** (or **virtual distance**) .



2b → Point : 5
If the object is placed on **the center of curvature**. The shadow that is formed will look, **real**, **inverted** and **same size**. The shadow will be placed at the **front** of the mirror.

Convex mirror



2c → Point : 5
If the object shadow on a convex mirror is always between the points, **O** and **F**. The nature of the shadow produced by a convex mirror are **virtual**, **erected** , and **smaller**.

3. A baby was playing within 100 cm Focal length 50 cm in front of a concave mirror. Determine;
   (a) the distance of the shadow (b) the magnification of the shadow. **Point : 2**
   Answer : (a) di = 100 cm; (b) m = 1x. The shadow and the object would be at the same size.

The math-equation of curved mirror.	The math-equation of curved mirror.
$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$	$m = \frac{h_i}{h_o} = \frac{d_i}{d_o}$

TOTAL SCORE : 15 POINTS

Appendix 9

The schedule of the cooperative learning condition.

Detailed Time Allocation				
Session/Day	Formal		Informal	
	Activity	Time allocation	Activity	Time allocation
Day 1 (INTRODUCTION & EXPERIMENTATION)	**Pre-test : Knowledge test and ASDQ II**			30 min
	Learning objectives informed	5 min	Learning objectives informed	5 min
	Role assignment	10 min		
	Grouping	5 min		
	Worksheet and activity overview	5 min	Worksheet and activity overview	5 min
Introduction Phase Formal (32 min) Informal (76 min)	Activating prior knowledge - Write individual answer - Group discussion/ write group answer - Self-reflection	10 min 3 min 5 min 2 min	Brain storming - Write individual answer - Turn-to-your partner discussion - presentation by 4 (four) pairs - self-reflection	20 Min 5 min 5 min 8 min (@ 2 min x 4) 2 min
	Information presentation1 - Read Information page - Discussion - Individual reflection	15 min 8 min 5 min 2 min	Information presentation 1 - Presentation by teacher - Individual reflection	25 min 20 min 5 min
	Match-making Discusion / write group answer	7 min	Match-making - Introduction by teacher ('Match-making' papers are distributed) - Turn-to-your partner discussion - Write group answer - Explanation by teacher	17 min 3 min 6 min 3 min 5 min
15 minutes break				
Experiment Phase Formal (91 min) Informal (62 min)	Prediction - Group discussion - write group answer - individual reflection	12 min 7 min 5 min 3 min	Prediction - Introduction by teacher ('spoon prediction' papers are distributed) - Write individual answer - Turn-to-your partner discussion - presentation by 4 (four) pairs - Self-reflection	28 min 5 min 2 min 10 min 8 min (@ 2min x 4) 3 min
	Experiment - Introduction by teacher (material distributed) - Observation – inner side - Write the result on. group worksheet - Observation - outer side - Write the result on. group worksheet - Group discussion - Write group answer - Individual reflection	35 min 5 min 4 min 1 min 4 min 1 min 10 min 5 min 5 min	Experiment - Introduction by teacher (material distributed) - Observation – inner side - Write the result on. group worksheet - Observation - outer side - Write the result on. group worksheet - Turn-to-your partner discussion - Write group answer	41 min 5 min 4 min 1 min 4 min 1 min 10 min 5 min

	** T assists only if the S ask for help.		- Presentation by 4 (four) pairs - Self-reflection ** T assists only if the S ask for help.	8 min (@ 2min x 4) 3 min
	Reflection - introduction of reflection phase by teacher - group discussion (inner side) - write group answer - write individual answer - group discussion (outer side) - write group answer - individual reflection on individual worksheet.	29 min 5 min 6 min 4 min 2 min 6 min 4 min 2 min		
	Information presentation 2 - group read ** T assists only if the S ask for help.	15 min	Information presentation 2 - Presentation by teacher	20 min
Day 2 **(Evaluation phase)** Formal (50 min) Informal (30 min)	- Group assignment - Group discussion - write group answer on the group worksheet and draw poster on A4 paper provided. - group presentation - group feedback	65 min 10 min 15 min 24 min (@ 3 min x 8) 16 min (@ 2 min x 8)	Assignment - T distinguishes groups in to two types of assignments (i.e convex and concave). - Introduction by teacher (problem paper is distributed)	40 min 5 min 5 min 15 min
			- Write individual answer - Turn-to-your partner discussion - Self-reflection	10 min 5 min
	- Group feedback session - Group reflection (one member opinion to one another) - Group writes their discussion result on group worksheet. - Individual reflection based on group discussion on individual worksheet. - Individual reflection on members opinion on individual worksheet.	14 min 8 min (@ 2 min x 4) 2 min 2 min 2 min		
	- Individual feedback session - Individual reflection on their involvement in group assignment on individual worksheet - individual reflection of the lesson on individual worksheet	20 min 10 min 10 min		
	Post-test : Knowledge test and ASDQ II			**30 min**