



CHAPTER 41

ADAPTING JIGSAW COOPERATIVE LEARNING STRATEGY IN SPECIAL NEEDS EDUCATION: AN EXAMPLE OF PHYSICS

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Introduction

Education is key to national socio-economic development and the instructional strategies in schools are the vehicles that teachers employ to facilitate learning in the learners for such development to be meaningful. Nigeria believes that education is a tool that can be used for its development. It also believes in providing equal educational opportunities to all its citizens according to their ability and irrespective of any challenge some of them may have. These positions were captured by the Federal Republic of Nigeria [FRN] (2014) in Nigeria's policy document on education. Special needs education (SNE), which the FRN defined as the formal special education that is given to the gifted and talented whose intelligent quotient is very high, the disadvantaged who cannot access conventional education and persons with disabilities (PWDs), is also included in Nigeria's policy on education. PWDs are persons with learning difficulties such as those with hardness-of-hearing and deafness arising from natural or accidental circumstances. They are included in the equal opportunities that Nigeria is offering its citizens towards realizing the nation's education goals. In the contemporary developed world, attention has shifted from teacher-centred instructional strategies to learner-centred strategies because of the advantages they have for the learner in the teaching-learning process. The jigsaw cooperative learning strategy (JCLS) is one of the learner-centred instructional strategies and can also be used in SNE.

This chapter which focused on adapting JCLS in SNE, explored what JCLS is, its advantages and disadvantages, how it can be utilized in the classroom by the teacher, instructing learners on the use of the strategy, the essential elements for using the strategy, example for implementing the strategy in Physics classroom to teach the concept of specific heat capacity, and the implications of adapting the strategy for special needs education/persons with disabilities.

The Jigsaw Cooperative Learning Strategy

The JCLS is a highly structured strategy of cooperative learning which was created in 1978 by Elliot Aronson and his colleagues. Maftai and Popescu (2012) viewed the strategy as one in which each learner of a cooperative group specializes in one aspect of a learning unit to resolve a task or class project. Learners in a class



are organized like pieces in a jigsaw puzzle to form different kinds of groups of 2-4 learners per group. These initial groups are called jigsaw cooperative groups, otherwise called jigsaw groups or home groups; and, in a jigsaw group each learner participates in obtaining the solution of a whole task called jigsaw puzzle. The learners are then re-organized into “expert” groups containing one learner from each jigsaw group having the same task part to accomplish. That is, each learner in a jigsaw group becomes an “expert” on one topic (unit of a whole task) by working with members from other jigsaw groups that are assigned the same “expert” topic. Maftai and Popescu (2012) further explained that the method involves dividing one lesson into sequences (the number equal to the number of jigsaw groups) that can be independently treated and that jointly achieve the lesson’s behavioural objectives.

The teacher who is preparing to use the JCLS to teach a concept is at a disposal to create jigsaw groups for lesson using teacher-assigned groups, randomly-assigned groups, social integration groups, subject-matter related groups, geographic groups or self-selected groups provided by MacPherson (as cited in Josiah, 2020). When using teacher-assigned groups, the teacher assigns learners to groups to ensure that the groups are heterogeneous. The advantage this way of forming groups has been that the teacher can ensure that groups are heterogeneous in terms of academic ability, ethnic background, gender and any other factors that may be relevant. The teacher further ensures that learners who are best friends or worst enemies are not placed in the same group since communication in the group may be ineffective, if they are.

In creating the randomly-assigned groups, the teacher simply has learners’ number off, placing all the ones in one group, the twos in another group, and so on, depending on the num

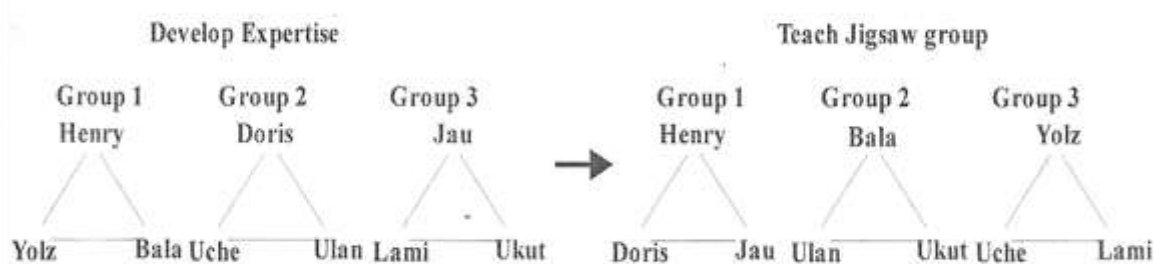
Number of learners required in each group. When forming the social integration groups, the teacher asks learners to privately name the learners they would like to work with and any they would not like to work with in groups. The teacher then uses the supplied information to construct the groups for the purpose of learning. When the teacher makes the choice of creating subject-matter related groups, he/she assigns learners into groups based on their individual interest in a particular concept. The groups can research and each group present their work to the rest of the learners in the class. When opting for geographic groups, the teacher places learners into groups such that learners who live near each other are in the same group for ease of meeting outside the classroom. To create self-selected groups, the teacher merely asks learners to form their own groups. However, opting for self-selected groups can be counter-productive if learners always end up in the same groupings.

After creating the groups, the teacher then appoints a group leader to be in charge of the group’s tasks. Next the teacher assigns the group a task, with each learner receiving an individual worksheet numbered 1 to 2-4 which indicates the workload. Each learner in a jigsaw group is in charge of completing a part of the



task. The teacher allots a certain amount of time for learners to complete their task. Then learners from different jigsaw groups who have the same task work together temporarily in expert groups to become "experts" on their topic and fill in any gap(s) in their information. Thereafter, learners come back together to their original jigsaw group and each learner presents his/her own information and provides an opportunity for the rest of the group learners to ask questions for clarification. While learners are teaching each other about the topic, the teacher moves around the classroom monitoring progress and answering any questions that learners might have about the topics. Finally, learners are assessed on the materials they have learned through the JCLS.

Modifications of the JCLS exist. These are Jigsaw I, Jigsaw II, Jigsaw III, Jigsaw IV, Reversed Jigsaw and Subject Jigsaw as submitted by Timayi, Bolaji and Kajuru (2015). In Jigsaw II, learners all research specific topics as opposed to parts of one larger group. It also requires that learners complete "expert sheets" which provide notes for introducing the topic back to base group and are given individual assessments as opposed to a group evaluation. Jigsaw II allows for a review process prior to assessment. Jigsaw IV allows for teacher introduction of materials, expert group quizzes, review process prior to individual assessment, and re-teaching of any material that was not adequately explored in the group work (Holliday, 2002; Smith, 2001; Timayi et al., 2015). From Mmegwa's (2020) study, it can be deduced that Jigsaw IV is similar to Reversed Jigsaw in that learners are first placed into jigsaw groups, assigned portions of a task, and regrouped into expert groups. However, Mmegwa submitted that learners in the expert groups teach the whole class instead of returning to their original jigsaw groups to teach. Illustrations of Jigsaw cooperative learning strategy groups are shown in Figures 1 and 2.



Step 1: Students meet in home groups							
John	Ali	Sule	Lerit	Zira	Joyce	Larai	Audu
Ulo	Vou	Dung	Joy	Abang	Musa	Alex	Bala



Fig. 1: Four-learner Jigsaw cooperative group (Source: Josiah, M. M, 2020).

Fig 2: T

three-learner Jigsaw cooperative group (Source: Josiah, M. M, 2020).

In the four-learner Jigsaw group, there are four learners assigned to each jigsaw group as depicted in Fig. 1. The first group comprises John, Ali, Ulo and Vou; the second consists of Sule, Lerit, Dung and Joy; the third is made up of Zira, Joyce, Abang and Musa; and the fourth group has Larai, Audu, Alex and Bala. The three-learner Jigsaw group has three learners placed in each jigsaw group for the purpose of learning (Fig. 2). However, in Fig. 2, the first step of Jigsaw group formation is latent. The first expert group has Henry, Bala and Yolz; the second comprises Doris, Ulan and Uche; the third is made up of Jau, Ukut and Lami. The learners in each expert group have the same part of a task to complete. There can be several of the four-learner and three-learner Jigsaw groups, depending on the number of learners in the class for the lesson.

Advantages and Disadvantages of Jigsaw Cooperative Learning Strategy

Many advantages of JCLS abound: The strategy is an activity of cooperative learning which aims at minimizing conflicts through social interaction amongst learners; thereby enhancing positive educational outcomes in learners. Maftai and Popescu (2012) posited that the JCLS seeks to avoid many of the problems of other forms of learning in a group. It helps learners to realize that they are essential parts of a whole and it encourages cooperation in learning. This implies that the strategy supports social relatedness, provides opportunity for autonomy, feeling of competence, and reduces competition amongst learners. The use of JCLS is



encouraged since it is known that engaging learners in expert groups keeps slower learners on pace with the rest of the class. When working in expert groups, learners who typically lag behind on whole class assignments or projects have the opportunity to discuss their materials and modify it accordingly.

Other advantages of JCLS provided by Johnson and Johnson (2009) include increasing achievement at all ability levels, improving retention and attitude, reducing frustration and anxiety among learners, and promoting inter-personal communication skills. Maftai and Popescu (2012) posited that the JCLS is highly effective in distance learning as learners can work with less guidance from their teachers; it has been used successfully to promote learning achievements across a range of curriculum areas, which includes Agriculture, Basic Science, Chemistry, English Language, Mathematics, Physics and Social Studies. Furthermore, it can be deduced from the studies of Areelu and Ladele (2018), Dhull and Verma (2019), Josiah (2022), Maftai and Popescu, that the strategy boosts learners' self-confidence by motivating them to learn; develops argumentative group communication and networking skills in learners; develops critical, logic and independent thinking in learners; develops individual learner and collective group learning responsibility; increases learners' interest to learn; and optimizes learners' achievement. Sengul and Katranci (2014) added that the strategy improves peer cooperation and creates group solidarity among learners, through task sharing. The JCLS does not accommodate domination of group by one learner who is competitive and wants to monopolize lesson session. The strategy does not really permit it because each member of the group is a valuable resource for the rest of the group on their given task. Aronson (2002) summarized the advantages of JCLS as follows: Learners that use the strategy are able to learn concepts faster and achieve higher in objective examinations than learners who learn same concepts using expository methods; the strategy encourages listening, engagement and empathy by availing each member of a jigsaw group with an essential role to play in academic activities.

Despite the advantages of the JCLS, a major disadvantage in the use of the strategy is time. Maftai and Popescu (2012) opined that the time allotted to subjects in schools is affected by learners' grouping, communicating individual or group workload, the distribution of work sheets and instructional materials. In addition, a jigsaw classroom requires more energy from the teacher and a well-devised lesson planning. Furthermore, a member of a group may not complete his/her portion of the group task due to laziness or some reason. For instance, such learner may choose not to work as hard as the others in the group, or simply allow the others to work it out for them. This one learner hurts the entire group and may bring down their morale and grade. Such a learner may simply not have the skills to help one another learn. To help surmount this disadvantage, the teacher must remain active within the groups.

Procedure Utilizing Jigsaw Cooperative Learning Strategy



Dhull and Verma (2019) and Smith (as cited in Josiah, 2020) provided insight into the procedure for structuring jigsaw groups when using the JCLS to teach concepts. The teacher thinks of a task he/she will give in the near future, divides the task into multiple (2-4) parts and then plans how to use the jigsaw procedure to teach the task. The teacher scripts out exactly what he/she will say to the class using each part of the jigsaw procedure. He/she needs to practice talking students through their role.

One way to structure positive interdependence among group members is to use the JCLS of creating resource interdependence. According to Smith (as cited in Josiah, 2020), the steps a teacher uses to structure a lesson when employing the strategy are:

1. **Jigsaw groups:** The teacher distributes a set of instructions and materials to each group. The set needs to be divisible into the number of members of the group. The teacher then gives each member one part of the set of materials.
2. **Preparation pairs:** Teacher assigns learners the cooperative task of meeting with someone else in the class who is a member of another jigsaw group and who has the same section of the material to complete the following two tasks:
 - a. Learning and becoming an expert on their material; and
 - b. planning how to teach the material to the other members of their group.
3. **Practice pairs:** Teacher assigns learners the cooperative task of meeting with someone else in the class who is a member of another jigsaw group and who has learned the same material and share ideas as to how the material may best be taught. These "practice pairs" review what each plans to teach their group and how. The best ideas of both are incorporated into each presentation.
4. **Jigsaw groups:** Teacher assigns learners the cooperative tasks of:
 - a. Teaching their area of expertise to the other jigsaw group members.
 - b. Learning the material being taught by the other members.
5. **Evaluation:** Teacher assesses learners' degree of mastery of the entire task. He/she identifies those groups where all members reach the preset criterion of excellence. The teacher may assess learners' mastery of all the material by giving every participating learner an examination, randomly calling on individual learners to explain the task they learned. The teacher may ask each group to process briefly, for example, by asking the group to identify at least one thing that each member did to help other members learn and at least three actions that could be added to improve members' learning next time. The teacher may also assess each group by marking learners' submitted finished works (Group and individual worksheets).

The JCLS can be an alternative to using the lecture method of instruction when the teacher has information, he/she needs to communicate to learners.

The teacher, being a facilitator, has the duty of reminding learners in the



jigsaw groups that learning a task is not a substitute for later studying the task individually; just as listening to a lecture is not a substitute for individual work. The teacher needs to also inform learners about the purpose of the JCLS which is to get each learner involved in the teaching-learning process; to give learners an overview; and to try to encourage learners to revisit learnt task more on their own outside the jigsaw classroom.

Instructing Learners on the Use of Jigsaw Cooperative Learning Strategy

The teacher instructs the learners on how to structure learning the jigsaw groups (Smith as cited in Josiah, 2020). This is done because JCLS is learner-friendly and the learners are expected to actively participate in the teaching-learning process. Instructing learners on the use of JCLS may also help in achieving the behavioural objectives of the lesson within the stipulated lesson period on the timetable.

Preamble: The teacher instructs the learners that each learner in a jigsaw group will be given a different section of the material (task) to be learned and that each learner is dependent on the others for success in learning all the material. Each learner is also accountable for teaching his or her material to the other group members and learning the material they are teaching. The learners are further instructed about the purposes of the JCLS, which are as to provide an alternative method of introducing new material besides lecture, create information interdependence among members to increase their sense of mutuality, ensure that participants orally rehearse and cognitively process the information being learned, and provide an example of high-performance teamwork.

Teaching and Learning Group: The teacher instructs the learners that the task in the jigsaw group is to learn all the assigned material, with the teacher ensuring that each learner has a different section and that all sections are covered. The teacher instructs learners to work cooperatively to ensure that all group members master all the assigned material.

Preparation of Learners to Teach by Pairs: The teacher instructs learners in the groups that they will be encouraged to take one section of the material and find a member of another group who has the same section of the material as they do; and that they will be required to work cooperatively to complete these tasks. The teacher instructs learners that they will learn in expert groups and become experts on portions of the given task. Thereafter, learners will plan how to teach their portion of the task to the other jigsaw group members. Learners in each group will share their ideas as to how best to teach their portion of the task and they are to ensure that their group members are ready to learn. The teacher instructs learners to further practice by consulting pairs; if a learner from an expert group finishes the preparation and has time, such a learner should meet with another student from a different expert group who is ready and who prepared the same portion of the task



the learner did. Both should work cooperatively to review what both have learnt and be ready to teach in their original jigsaw groups.

Essential Elements for Using Jigsaw Cooperative Learning Strategy

Slavin (2011) provided two essential elements for JCLS to be effective. The first essential element is that there must be a group goal for the learners. This can be a certificate, a few minutes of free time, or even bonus points on a grade. Group goals are important to motivate learners to help one another. Without a group goal, learners may not give adequate explanations to their team members about their subtopics because they were not motivated to do so. The second essential element is individual accountability. There should be some form of assessment that recognizes the efforts of each individual learner. This will encourage all group members to do their jobs well because everyone's grade may be dependent on the information, they give to fellow group members. The JCLS can increase learner achievement if a group reward is given on the basis of individual achievement of the group members.

Example for Implementing the Jigsaw Cooperative Learning Strategy in Physics Classroom

Josiah (2020) supplied an example for implementing the JCLS in Physics classroom. The Physics teacher can employ the JCLS to teach a forty-minute concept of specific heat capacity to senior secondary two (SS II) students, with the following behavioural objectives: Explain the relationship between heat energy supplied to a body and its temperature change at constant mass; explain the term heat capacity of a body; define the term heat capacity of a body; show that the unit of heat capacity is J/K; explain the term specific heat capacity of a body; define the term specific heat capacity of a body; and, show that the SI unit of specific heat capacity of a body is given by J/kg.k.

A brainstorm activity is useful to apply before the start of work, as well as creating a problem situation, or a few minutes' discussion to reinforce previously acquired knowledge. The teacher can discuss concept of temperature and effects of heat on change of state as prior knowledge to the lesson on specific heat capacity, as students have learnt them in senior secondary one (SS I). Moreover, they have, at one point or the other, experienced temperature change by coming into contact with a body at higher temperature.

The steps to be taken in the example are as follows:

Introduction

- i. **Teacher's activity:** Teacher creates heterogeneous jigsaw groups, each of four students with students representing high and low ability levels. He/She assigns group leaders to be in charge of the groups' tasks. He/She assigns numbers 1-4 to each member of a group: Using Fig. 1, the students in the first jigsaw group are John, Ali, Ulo and Vou; those in the



second group are Sule, Lerit, Dung and Joy; those in the third group are Zira, Joyce, Abang and Musa; those in the fourth group are Larai, Audu, Alex and Bala. Thereafter, the teacher creates a problem situation by asking the students if they had at one point or the other come into contact with a body at higher temperature. Teacher also asks what their experiences were.

- ii. **Students' activity:** Students are given the opportunity to respond to the problem situation. Possible answers will be 'Yes'. Some will mention that their hands had unknowingly come into contact with a hot pot while cooking.

Lesson Presentation

STEP 1

The teacher buttresses the answers supplied by the students. He/She explains that the burning sensation felt each time the students come in contact with a body that is at a higher temperature is as a result of heat energy that flows from the body at higher temperature to their body part that came into contact with the hotter body. He/She further explains that the addition of heat energy to a body causes the temperature of that body to rise, but as the heat is removed the temperature falls. The teacher explains that the quantity of heat energy (Q) supplied to a body is directly proportional to the mass (M) of the body, change in temperature ($\Delta\theta$) and also depends on the nature of the material that makes up the body.

STEP 2

- i. **Teacher's activity:** The teacher distributes worksheets to all members in the created groups according to the tasks that will be assigned to the students numbered 1-4.
- ii. **Students' activity:** Students No. 1 in the four jigsaw groups (John, Sule, Zira and Larai) will each receive a worksheet labeled Student No. 1 Worksheet with the following information: Q = quantity of heat received by a body, M = mass of the body, $\Delta\theta = \theta_2 - \theta_1$ = change in temperature.
Students No. 2 in the four jigsaw groups (Ali, Lerit, Joyce and Audu) will each receive a worksheet labeled Student No. 2 Worksheet with the following information: M = entire mass of a body, change in temperature $\Delta\theta$ is such that $\Delta\theta = \theta_2 - \theta_1 = 1\text{k}$ (unit temperature), Q = quantity of heat energy supplied to the entire mass of the body.
Students No. 3 in the four jigsaw groups (Ulo, Dung, Abang and Alex) will each receive a worksheet labeled Student No. 3 Worksheet containing the following information: Q = quantity of heat supplied to a body, m = unit mass of the body, $\Delta\theta = \theta_2 - \theta_1$ = change in temperature.
Students No. 4 in the four jigsaw groups (Vou, Joy, Musa and Bala) will each receive a worksheet labeled Student No. 4 Worksheet with the following formulae: The following are formulae for quantity of heat energy (Q)
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supplied to a body and heat capacity (C): $Q = mc\Delta\theta$ and $C = Mc$ where M is the mass of the entire body, m is the unit mass of the body, $\Delta\theta = \theta_2 - \theta_1$ is the change in temperature and c is the specific heat capacity of the body.

STEP 3

- i. **Teacher's activity:** Teacher allots time for each member in the jigsaw groups to work their part of the assigned tasks in step 2 of the lesson plan.
- ii. **Students' activity:** Each member of jigsaw group works his/her part of the task within the allotted time.

STEP 4

- i. **Teacher's activity:** Teacher forms expert groups, with each group having four students from jigsaw groups having the same task to complete. The teacher allots time for students in expert groups to complete their task.
- ii. **Students' activity:** Each student in an expert group shares his/her workings in the group and fills in any gap(s) in their information (working).
Students No. 1 in the expert group (John, Sule, Zira and Larai) will establish the relationship between quantity of heat energy (Q) supplied to a body, temperature change ($\Delta\theta$) and mass (M) of the body.
Students No. 2 in the expert group (Ali, Lerit, Joyce and Audu) will explain that the heat capacity of a body is given by $C = Mc$. They will also define heat capacity of a body.
Students No. 3 in the expert group (Ulo, Dung, Abang and Alex) will explain that the specific heat capacity of a body is given by $c = \frac{Q}{m\Delta\theta}$. They will also define specific heat capacity of a body.
Students No. 4 in the expert group (Vou, Joy, Musa and Bala) will show that the SI units of specific heat capacity and heat capacity of a body are given by J/kg.K and J/K respectively.

STEP 5

- i. **Teacher's activity:** Teacher moves round to observe and ensure that each student and group is working. He/she also asks questions and provides clarifications, where necessary.
- ii. **Students' activity:** Each student in the expert group ensures that he/she works towards achieving the task assigned.

STEP 6

- i. **Teacher's activity:** Teacher informs the students to go back to their original jigsaw groups.
 - ii. **Students' activity:** Each student goes back to his/her original jigsaw group to teach their area of expertise to the other jigsaw group members and to learn the material being taught by the other members. Students No. 1 start the teaching, followed by Students' No. 2. After that, Students No. 3 will teach and finally Students' No. 4 will teach their area of expertise. The leader
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of each jigsaw group summarizes his/her group work and submits, together with the individual worksheets of members in the group, for assessment.

Lesson evaluation: Teacher evaluates the lesson by asking the following questions:

- i. Define heat capacity of a body.
- ii. Define the specific heat capacity of a body
- iii. State the formula for heat capacity of a body.
- iv. State the formula for specific heat capacity of a body
- v. State the SI unit of heat capacity of a body
- vi. State the SI unit of specific heat capacity of a body

Summary: Teacher corrects the summaries presented by the groups and writes them on the board.

Assignment: The teacher gives the following questions to the learners as an assignment:

- i. Explain the term Specific heat capacity of a body.
- ii. How would you measure specific heat capacity of a solid by the method of mixtures?
- iii. How would you determine specific heat capacity of a solid and that of a liquid by electrical method?

Conclusion

Education is a viable tool for creating a robust economy of a nation. If the citizens of Nigeria will contribute their quota towards developing a robust economy, they must be actively involved in the teaching-learning process. This can only be achieved by equipping the teacher with the varying instructional strategies which can be used to impart knowledge to the citizens. In the contemporary world, learner-centred strategies are preferred to teacher-centred strategies because of the active participation which learners are presented with by the learner-centred strategies.

Although there are many learner-centred instructional strategies at the disposal of the teacher, the JCLS being only one of them, can be employed because of its great and numerous advantages in the teaching-learning process. This advantages include motivating learners towards learning, enhancing students' performance, supporting social relatedness, providing opportunity for autonomy, feeling of competence, and accommodating different cognitive ability levels in learning.

Implications of Adapting Jigsaw Cooperative Learning Strategy for Special Needs Education/Persons with Disability

The following are implications of adapting JCLS for special needs education (SNE)/persons with disabilities (PWDs):

1. Through task sharing, the JCLS will improve peer cooperation and create group solidarity among PWDs. The strategy does not accommodate



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- domination of group by one member who is competitive and wants to monopolize activities, because the strategy places each member of the group as a valuable resource for the other members of the group.
2. When taught using, the motivation towards learning of PWDs could be improved upon, since JCLS has been found to motivate students towards learning and consequently improve their achievement.
 3. The JCLS will enhance the academic performance of PWDs in the classroom, as it has been used successfully to promote learning achievements across a range of curriculum areas. Such students are also able to master the concepts they are taught.
 4. When JCLS is used to teach PWDs, the slower learners are encouraged to learn, since it is known that engaging learners in expert groups keeps such learners on pace with the rest of the class. This means that PWDs who are slow learners have the opportunity to discuss their knowledge and modify it accordingly in expert groups.

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