

DESIGN DIDACTIC ACTIVITIES USING GAMIFICATION: THE PERSPECTIVE OF TEACHERS

Cecilia Fissore¹, Valeria Fradiante¹, Marina Marchisio¹ and Claudio Pardini²

¹*Dipartimento di Biotecnologie Molecolari e Scienze per la Salute, Università di Torino*

Via Nizza, 52, 10126 Torino TO, Italy

²*Comitato Scientifico PP@S, Italy*

ABSTRACT

In recent years, gamification has raised considerable interest in various fields, including industry, healthcare, business and education. Moreover, the spread of technological and IT tools has contributed to the claim of new methodologies, approaches and tools, such as games, in the education field. Teachers are often attracted by gamification but they do not know how to put it into practice. It is therefore necessary to train teachers not only on the theoretical contents, but also and above all on the planning of didactic activities to adopt innovative educational approaches. The context of this research is the immersive 3-hour workshop on the theme "Gamification and education: innovative approaches to facilitate learning" which involved 54 teachers from all over Italy from primary to secondary school. After a short theoretical introduction, the teachers were guided through the individual step-by-step creation of a gamification activity. The research questions are: Which are the most frequent characteristics, factors and elements of gaming employed in the planning of didactic activities by school teachers? What were the most adopted gamification strategies? To answer the research questions, we analyzed teachers' responses to the initial questionnaire before the workshop and to the final questionnaire at the end. We considered also the design forms filled by teachers in order to understand how teachers employed the proposed methodology within their educational activity. The results show that teachers really appreciated the proposed methodologies and they tried immediately to put them into practice.

KEYWORDS

Gamification, Gaming and edutainment, Mathematics, Primary school, Secondary school, Teacher training

1. INTRODUCTION

According to the opinion of several researchers, if properly planned, gamification can favor and improve the learning and teaching of the subject to be studied (Behl et al., 2022). The term gamification refers to the use of the typical mechanisms of the game, such as the challenge, the use of points, levels and prizes, in a context that is essentially not a game (Deterding et al., 2011). It also represents a multidisciplinary approach that includes theories, practices and technologies. In education, teachers are often attracted by gamification but they do not know how to put it into practice within their teaching practices. To this purpose, it is necessary to train teachers not only on the theoretical contents inherent to these themes, but also and above all on the planning of didactic activities to adopt innovative educational approaches. In this sense, the Problem Posing and Solving (PP&S) project of the Ministry of Education (www.progettopps.it) promotes the training of Italian teachers of primary and secondary schools on innovative teaching methods, such as Gamification, with the use of ICT, and gives continuous support to teachers of all types and disciplines (Barana et al., 2019a; Fissore et al., 2020).

The context of this research is the immersive 3-hour workshop on the theme "Gamification and education: innovative approaches to facilitate learning", organized within the PP&S project. The workshop involved 54 teachers from all over Italy from primary to secondary school and it took place face-to-face in March 2023 with a desire to learn and innovate their teaching practices. The first hour of the workshop was focused on a theoretical introduction on the topic with group discussion and interactions between teachers and trainers. Then, several examples of educational activities of different levels using gamification approach were given. The rest of the workshop was spent to group planning of a didactic activities using gamification. In this stage teachers reflected on gamification strategies to be used in their activity, as well as on the theoretical contents,

objectives and prerequisites. Trainers have provided teachers with a design form to guide them in planning the activity, which asked to explain the main characteristics of their work (e.g. synchronous/asynchronous, individual/in groups), the gaming factors (e.g. involvement, control, rewards, fun, progress, accumulation, personalization and adaptability) and the gaming elements (e.g. challenge, leaderboard, points/coins/treasures, make choices, variation depending on choices, avatars, storytelling). At the end and at the beginning of the workshop participants were asked to fill an initial and a final questionnaire. The research questions are:

- Which are the most frequent characteristics, factors and elements of gaming employed in the planning of didactic activities by school teachers?
- Which were the most adopted gamification strategies?

To answer the research questions, we analyzed teachers' responses to the initial questionnaire and to the final questionnaire. We considered also the 36 design forms developed by teachers in groups in order to understand how teachers employed the proposed methodology within their didactic planning.

The paper is structured as follows: in Section 2 the State of the art is outlined, in Section 3 research Methodology is presented together with workshop modalities and type of data collected, in Section 4 the Results are showed while in the final sections results are discussed and Conclusions are drawn.

2. STATE OF THE ART

2.1 Gamification

The spread of technological and IT tools in recent decades such as computers, smartphones, tablets, through which it is possible to play everywhere, has contributed to the claim of new methodologies, approaches and tools, such as games, in the education field. At the beginning there was a strong skepticism towards the use of games in education, since it was believed that games had the only purpose of entertaining the participants (De Freitas, 2006). Although, today gaming and gamification represent new ways of interaction, learning and exploration and contribute to the achievement of a defined purpose, different from pure entertainment (Dimoulas et al., 2021). The term gamification refers to the use of the typical mechanisms of the game, such as the challenge, the use of points, levels and prizes, in a context that is essentially not a game (Deterding et al., 2011). Unlike serious games, which are tools designed and developed as game tools from the very beginning, gamification represents an approach that involves the application of characteristic elements of the game within modules or learning units that were not necessarily born as games (Deterding et al., 2011). Many studies have shown how gamification can be successfully adopted in higher education contexts, (Čeponienė et al., 2019) and how in the case of distance learning it can stimulate interaction and engagement (De la Peña et al., 2021). It can be adopted as a methodology to simplify students' approach to disciplines, especially when combined with the use of adaptive learning, formative assessment and interactive feedback (Barana et al., 2022, Corino et al., 2022a). Furthermore, gamification enables the user to experience situations that would otherwise not be accessible and provides a safe place where multiple trials can be performed. For example, it is used in the health and safety field to educate people to behave responsibly (Dimoulas et al., 2021). One of the most difficult parts of using game mechanisms in non-game context consists in knowing how to wisely balance learning and game aspects (Bente & Breuer, 2010). On the one hand, game elements are important to engage and motivate students, but on the other hand it is necessary not to lose sight of the learning goals.

People who play are motivated by certain factors that characterize games:

- **Involvement:** players like to feel they have an active role in the game and they are therefore encouraged to participate dynamically. The challenge is one of the key elements to engage users within the game.
- **Control:** players like to feel they have power and control over their actions.
- **Rewards:** prizes, even small ones (e.g. badges or achievements) encourage players to keep going, especially when the rewards are regular.
- **Fun:** users enjoy the game because it is interesting and they will continue to play as long as there is interest.

- Progress: players are stimulated to continue the game if they have the impression that they are moving forward, getting better, gaining skills. The use of levels in the game is an incentive factor for the user who can be motivated by the progression in the challenge. Another element used in games is the leaderboard to stimulate users to play and get better and better results.
- Accumulation: those who play appreciate the possibility of being able to accumulate rewards (e.g. money, treasure, points).
- Personalization: players like to customize the game, for example by choosing an avatar to develop an own identity.
- Adaptability: players like the possibility of making the game vary depending on their decisions, whose path is the result of their own choices.

These are real needs of the players that the game must be able to satisfy. Gamification exploits the most commonly appreciated advantages and aspects of games to keep students' participation, involvement and motivation high in order to generate positive attitudes that can promote learning (Deterding et al., 2011). Storytelling represents another gamification strategy: telling a story, event, myth, legend or mission is one of the most used ways to involve the user (Chorianopoulos & Giannakos, 2014). A gamification activity can also be an opportunity to favor collaborative learning among students and for the achievement of specific common goals, for example by taking part in a challenge that involves teamwork. In fact, many games make available chats, forums or other tools to allow communication and interaction between users that helps to create a community that plays (Chorianopoulos & Giannakos, 2014).

2.2 The Digital Learning Environment of PP&S Project

The PP&S - “Problem Posing and Solving” - project (available at www.progettopps.it), headed by the Italian Ministry of Education, since 2012 has been promoting the training of teachers from primary to secondary schools on innovative teaching methods through the use of digital technologies. Teachers involved in the project learn how to use different kinds of digital tools and new methodologies, such as gamification, in order to enhance their daily didactic (Fissore et al., 2020). By enrolling in the project, totally free of charge, teachers have the possibility of having an integrated Digital Learning Environment (DLE) for all the classes of students they need. The use of a DLE, for online or hybrid teaching, can support the implementation of gamification teaching activities (Barana et al., 2022). Within the DLE, students are provided with multiple resources (interactive materials, links, videos, theoretical explanations, etc.) and numerous synchronous and asynchronous other online activities. At the same time, teachers develop gamification teaching activities for their students at a distance, within a DLE dedicated to the community of PP&S teachers, who also collaborate with each other exchanging ideas, teaching strategies and materials reviewed and tested in their classes. They also develop activities in collaboration with the tutors at a distance during the online training sessions (Barana et al., 2020).

Table 1 shows an example of designing mathematical activity using gamification, illustrated to teachers during online training activities and during this workshop. The activity also offered an example of compilation of the guided form that teachers have to fill in the planning of their activity.

Table 1. Battleship: example of a mathematical activity using gamification used to train teachers

Title	Battleship
Discipline	Mathematics
School grade	Grade 9/10
Duration	3 hours
Topic	Representation of points on the Cartesian plane
Goals	Familiarize with the Cartesian plane Use the Cartesian plane to locate points Recognize points, segments and figures on the Cartesian plane
General characteristics of the activity	Synchronous and asynchronous moments Groups of 2/3 students Self-assessment

Sink the enemy ship which lies in the rectangle $[-2,-1] \times [1,2]$ (see Fig.1). In turn, a student chooses a point on the plane and communicates it to his mate, who selects an abscissa and an ordinate and shoot

Brief description of the activity	to hit the goal. More rounds of the game are foreseen if teacher varies the position of the goal and it is possible to introduce a partial and total leaderboard of the participants. A score based on the number of attempts is assigned (high number of attempts = low score). More levels could be inserted depending on the score obtained. The prize for each round could be the chance of choosing the goal position, instead of the teacher, for the next round during which the other teams will compete. The activity continues with a common mission for the class: sink the enemy ship which is located in an unknown area of the Cartesian plane. The exchange of information among groups is fundamental in identifying the winning area and can take place in asynchronous ways, such as through a forum or a specific chat. The game can be repeated several times by varying the winning area Involvement, control, rewards, fun, progress, accumulation, and adaptability
Gaming factors	Challenge, leaderboard, points, make choices, variation depending on choices, storytelling
Gaming elements	

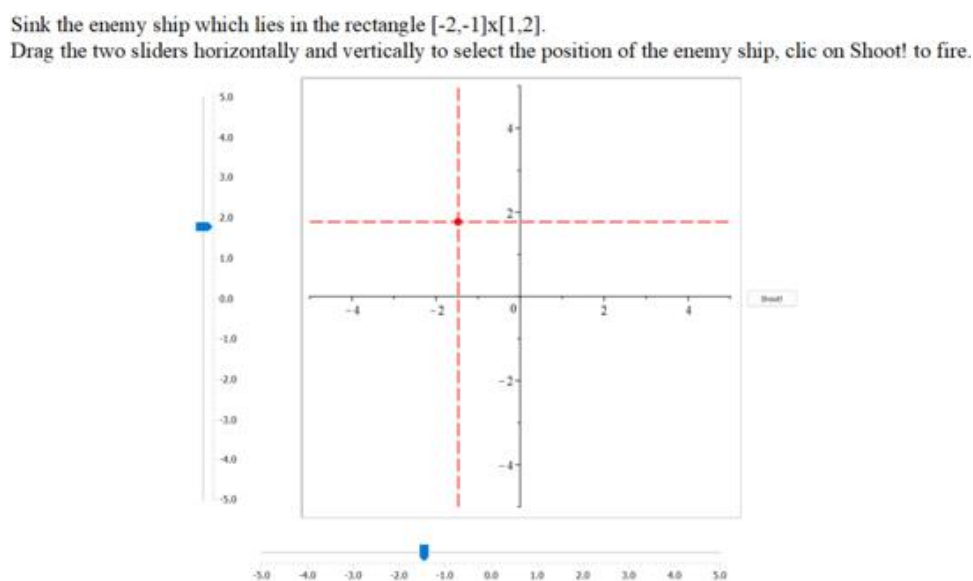


Figure 1. Interactive educational material used for the “Battleship” activity in Table 1

The DLE of the PP&S support gamification strategies. For example the forum activity supports collaboration and discussion between users. There are several tools to show students the level achieved, the position in the ranking and the progress. Moreover, it is possible to access to interactive worksheets, that we used to build the “Battleship” activity. The platform also allows users to receive badges depending on their goals.

3. METHODOLOGY

The context of this research is the immersive 3-hour workshop on the theme "Gamification and education: innovative approaches to facilitate learning" which involved 54 teachers from all over Italy from primary to secondary school. To answer the research questions, we analyzed the design forms provided by trainers to guide teachers in planning the gamification activity and their responses to the initial and final questionnaires. The first one investigated teachers' data (age, level of education, school, discipline, etc.) and prior experience and knowledge about gamification and the perception of their own teaching practices. Using Likert scale questions (1=Not at all, 2=Very little, 3=Somewhat, 4=Much, 5=Very much) we asked teachers how much they usually pay attention to the following aspects in their teaching practices: motivation, engagement, cooperation between students, adaptability, inclusion and involvement. In the final questionnaire teachers reflected on methodologies proposed to support innovative teaching and how these favor the understanding of different aspects: catching students' attention, increasing motivation for the subject to study, involving students, developing their autonomy and responsibility and personalizing learning activities. Furthermore, they

expressed their appreciation for the workshop in various aspects and for the proposed methodologies to support innovative teaching. The first hour provided a brief introduction to the topic and then a group discussion and interactions between teachers and tutors. The example of a Mathematics activity using gamification in Table 1 was also shown. The rest of the workshop was spent group planning a didactic activity through the compilation of a guided form to help teachers in designing a didactic activity using gamification. This form was created on the basis of the illustrated theoretical framework. The requests of the form are shown in Table 1. The activity presented to the teachers, in fact, served both to show an example of educational gamification activity and to explain how to design the activity using the form. The first part of the form required general information about their activity, such as title, disciplines involved, target, duration, topics and goals. The second part, focused on gamification, asked teachers to explain the main characteristics (synchronous/asynchronous, individual/in groups), the gaming factors (involvement, control, rewards, fun, progress, accumulation, personalization and adaptability), and the gaming elements (e.g. challenge, leaderboard, points/coins/treasures, make choices, variation depending on choices, avatars, storytelling etc.) of their gamification activities.

4. RESULTS

Our sample is composed by 47 teachers for the initial questionnaire and 36 for the final questionnaire. 36 activities were designed by teachers through the guided form, less than the number of participants since some of them worked in groups and submitted the same activity. From the initial questionnaire it was found that only one teacher was under 30 years old, 9 were between 30 and 40 years old, 21 between 41 and 50 years old, 15 between 51 and 60 and only one was more than 60 years old. Only one was primary school teacher, 18 were lower secondary school teacher, 27 were upper secondary school teacher and one was a head teacher. As shown in Fig. 2, half of them already had prior knowledge of gamification before the workshop. Most of them stated that they usually pay attention to those aspects in their teaching practices: motivation and engagement of students (98%), collaboration between peers (98%), adaptability of learning (85%), inclusion (98%) and involvement (100%). Therefore, the sample considered is composed by teachers who are willing to actively involve and motivate their students in the learning process; perhaps it is only necessary to make them reflect with a greater awareness on the methodologies they already employ for this purpose and to train them on innovative educational approaches and practices. In this sense, they attended the workshop to learn how to put in practice those aspects through gamification, and it will be easier for them to approach this methodology because the key elements will not be new.



Figure 2. Teachers' prior experience and knowledge about gamification

Even if some teachers answered only the initial questionnaire (11 teachers), since they could not stay until the end of the workshop, we consider all their responses as an expression of their pre-workshop perspectives on didactics and gamification. Those who filled the final questionnaire also designed the gamification activity. 86% of teachers stated that they gained interesting ideas and stimuli from their teaching practices from the workshop. About half of them identified the workshop as a useful occasion to reflect and rethink on their teaching methodologies in order to achieve greater clarity and awareness for didactic design. Teachers created 36 different activities, less than the number of the workshop participants, since some of them had collaborated and designed the same activity. 22 of them are addressed to upper secondary school, 13 for lower secondary school and one for primary school. Regarding the disciplines involved, 15 activities are focused on Mathematics topics, 5 on Science, 3 on Computer Science, 3 on Philosophy, History and Italian, 1 on Music and 9 are multidisciplinary activities which cover simultaneously different subjects, such as Civics,

Art, Geography. All activities are designed to be performed synchronously and 17 also include asynchronous moments. 35 out of 36 activities provide collaboration between students in small or big groups. We have analyzed also the most frequent gaming factors (involvement, choice, control, rewards, fun, progress, accumulation, personalization and adaptability) and the gaming elements (e.g. challenge, leaderboard, points/coins/treasures, make choices, variation depending on choices, avatars, storytelling etc.) employed in their designed activities. As shown in Fig. 3, teachers preferred to include some gaming factors and elements instead of others. In particular, all the activities are designed to actively involve students and they provide rewards (75%), personalization (61%) and make students' progress (78%). Teachers employed other factors less: control (42%), fun (36%), accumulation (36%), adaptability (25%). Perhaps they found these aspects more difficult to put in practice in a didactic activity. It is worth noting that the adaptability of learning was the indicator that obtained the lowest score in the initial questionnaire: its implementation in teaching practices turned out to be complicated. Regarding gaming factors, teachers employed different strategies: the most part inserted challenges (86%), levels (67%) and leaderboards (53%). About half of activities enable students to accumulate points/coins/treasures (50%), to win prices (44%) and make choice (44%). Only few teachers inserted avatar (28%) or invented stories (33%) or provided variations depending on choices (33%) within their activities. These aspects are also more complex to design and implement in a teaching activity.

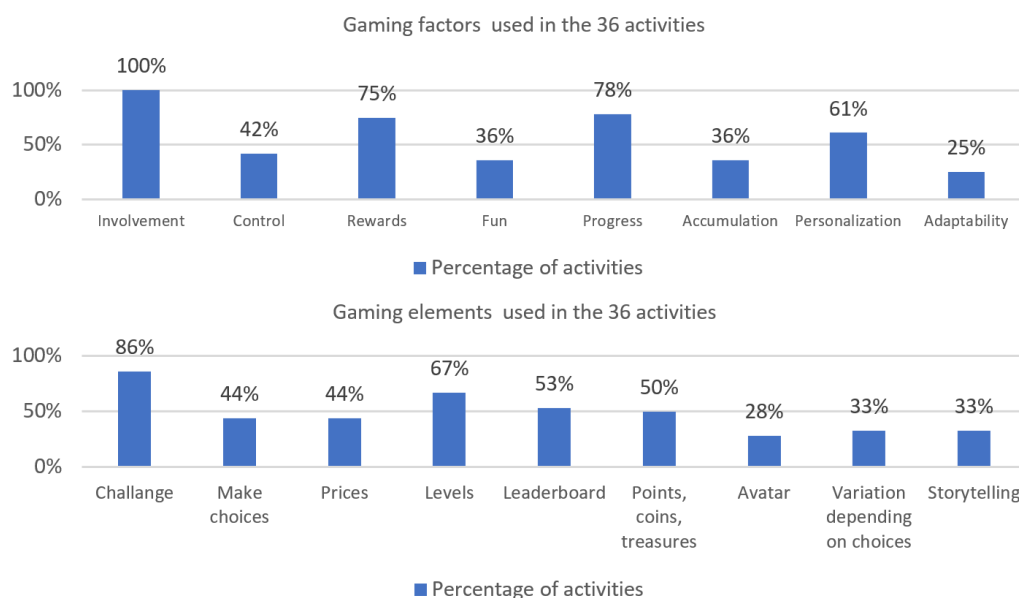


Figure 3. Teachers' choices of gaming factors and elements.

One of the most successful activities, showed in Table 2, is entitled "Crossword-Euclid". The activity was designed by a teacher of Mathematics of lower secondary school on Euclidean geometry topics. The goals of the activity are: to familiarize with fundamental geometric entities; to understand the main axioms of Euclidean geometry, and to distinguish and classify fundamental geometric entities. The activity is very interesting because it uses a well-known gamification element such as the crossword puzzle, but in a completely new context. The activity also involves both designing and solving a crossword puzzle. Since there is a score, the students know that they must not formulate the definitions too easily but neither too difficult or incomprehensible, because then it would not be mathematically correct. The most interesting aspect of the activity is that it links linguistic aspects to mathematical aspects. The activity could lead to a collaboration among Mathematics and Italian teachers, since students do not always know how to speak and write about Mathematics topics and often students' mathematical difficulties depend on linguistic difficulties (Corino et al., 2022b). It would be interesting to implement this task using encrypted crossword puzzles. Linguists consider these question types effective to develop language competences and have already used them profitably in traditional teaching and language learning (Barana et al., 2019b).

Table 2. Crossword-Euclid: example of activity designed by Mathematics teacher

Title	Crossword-Euclid
Discipline	Geometry
School grade	Grade 6
Duration	3 hours
Topic	Fundamental geometric entities: segments, angles, lines and polygons
Goals	Familiarize with fundamental geometric entities Understand the main axioms of Euclidean geometry Distinguish and classify fundamental geometric entities
General characteristics of the activity	Synchronous Groups 3/4 students, Collaboration between students
Brief description of the activity	Students create a crossword puzzle using an open-source software, where they have to insert terms of the fundamental geometric entities and their respective definitions. Each group must solve the crosswords made by the other groups which will be randomly assigned in various rounds. A leaderboard of the groups that manages to achieve the highest number of correct definitions in the shortest time is drawn up for each round. There is a time penalty: in each round those who lie in the last 3 positions of the leaderboard must wait 1 minute to solve the next crossword. The first group to complete all crosswords correctly wins a badge.
Gaming factors	Involvement, rewards, fun, adaptability
Gaming elements	Challenge, leaderboard, points, prize

To engage the learners and increase motivation, crossword puzzles can be implemented using an automatic grading system in a DLE (Barana et al., 2019b). This is why it is important to train teachers on innovative teaching methodologies but also on the development of digital skills. Table 3 shows another example of activity designed by teachers on conscious daily use of water. The activity not only allows to develop curricular skills, but it is aimed at practicing skills that can be used in everyday life: to understand the amount of water used in daily life and to learn to read and use different kinds of graphical representations.

Table 3. Use or waste: example of activity designed by a Technical Education teacher and a Science teacher

Title	Use or waste
Discipline	Technical Education and Science
School grade	Grade 7
Duration	2 hours
Topic	Estimation, reading and using graphs Understand the amount of water used in daily life
Goals	Learn to read and use different kinds of graphical representations Synchronous, Asynchronous,
General characteristics of the activity	Groups 5 students, Collaboration between students, Discussion between teachers and students
Brief description of the activity	The teacher divides the class into teams (5 students per team). Each team has got an amount of water and has to manage and use it for daily uses for 3 days. First rule is not to give up basic functions (washing and cooking). Whoever manages to survive up to 3 days with the amount of water given wins, perhaps with still water available.
Gaming factors	Involvement, rewards, fun, adaptability accumulation
Gaming elements	Challenge, make choices, variation depending on choices, levels, prize, leaderboard

5. CONCLUSION

This paper presents the results of a workshop on gamification and education that involved 54 Italian teachers of different levels. From the initial questionnaire we found that the sample considered is composed by teachers who are willing to actively involve and motivate their students in the learning process and that they were open

to discover and learn new teaching methodologies to use in their teaching practices for these purposes. This fact highlights the need to train teachers who are very often attracted by innovative methodologies such as gamification, but they do not know how to put them into practice in their daily teaching practices. As the final questionnaire shows, thanks to the workshop they were able to discover interesting and clear methodologies and strategies to support innovative teaching, useful to better engage and motivate students in learning processes and to help them develop competencies. Through the analysis of the guided forms filled by teachers during designing stage, it was possible to study which are the most frequent gamification strategies used by teachers to create activities that allow students to achieve goals and skills in the disciplines they teach. All the didactic activities entail collaboration among students, for example to achieve a common mission or goal. Regarding gaming factors, the most frequent are involvement, rewards, personalization and progress, which have been implemented mainly through the use of challenge, levels, leaderboards and points/coins/treasure. From the initial questionnaire and from the guided designing forms, teachers' difficulties in achieving an adaptability of learning emerges. A future challenge could be to help teachers enhance their teaching practices, through practical tools and advices, to achieve a greater adaptability. The experience led to the production of valid gamification educational activities and was full of very interesting ideas. The same experience can also be offered to the students. Since teachers really appreciated activities and methodologies showed during the workshop, we think that a further step can be the creation of a database of didactic activities using gamification approach on different topics and disciplines that can be shared among a wide community of teachers, from primary to upper secondary school, in a vertical perspective, as well as the PP&S community. The results show that the experience can be presented at all levels and facilitate dialogue between teachers who teach different subjects at different schools.

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