# Three Minds Are Better than One

## Collaborative Teaching in an Interdisciplinary Science Course

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**A recent article published by the Royal Society of Canada states that "solving many of the world's complex and pressing problems demands thinking and working across long-standing, but in some ways restrictive, academic boundaries" (Cooke *et al.*, 2020). No doubt educators need to model an interdisciplinary approach to teaching, but there is no denying the difficulty of designing such courses that work over the long term. Imagine, then, when the minds of three science teachers join forces to create an interdisciplinary course. The results are striking, not only because they present a model that has proven itself over the years—and that respects both teacher autonomy and the spirit of collaborative teaching—but also because they highlight the challenges of such a pedagogical venture. In this article, a brief review of the literature on collaborative teaching is followed by an account of the context for the development of an interdisciplinary science course and its role within the Criminology option of the Social Sciences program at Champlain Saint Lambert College. A review of student comments and recommendations to support the implementation of such a course completes this account of a lasting collaborative experience.**

This shared practice describes the experience of 15 years of teaching an interdisciplinary course, *Introduction to Forensic Science*, with three different disciplines: biology, chemistry and physics. The precise examination of this course is of interest because:

- It has been taught continuously for many years, so it has **longevity**
- It has **resilience**, having continued through changes in teachers and college administration
- It has **authenticity** as a representation of a complex field (Forensic Science)
- It has **success** in terms of student outcomes and student enrolment
- It has **flexibility** as it can be applied to almost any course, and
- It is a **proven model**—particularly for integrative science courses—which has the potential to transfer to other disciplines that may want to explore collaborative teaching.

## Hopes and challenges of collaborative teaching

Collaborative teaching is when two or more instructors teach the same group of students with shared planning, instruction, and assessment. (Chouvarda *et al.* 2019). This team-based approach is useful for interdisciplinary learning (Bryant *et al.*, 2018), which is when students integrate knowledge from different disciplines to address complex, real life problems (Woods, 2007). Johnson *et al.* (2000) summarize the benefits for students of interdisciplinary learning through collaborative teaching: students are shown to use higher level reasoning strategies, have better retention and knowledge, and have better decision-making strategies. Teachers also benefit by gaining new perspectives from being forced to examine their understanding of their own discipline, and by gaining a better understanding of other disciplines and departmental cultures (Burkhardt, 2006). Although collaborative teaching has been studied and promoted for many decades, it is rarely practiced at the college level. How to explain such a situation?

The reason that there are relatively few interdisciplinary courses is mainly because they challenge the *status quo*, wherein departments are organized to be self-autonomous and to exist in relative isolation from each other, with significant differences between departmental norms and values. (Burkhardt, 2006). In addition, administrative systems are not well suited to dealing with collaborative teaching, so there are logistical difficulties in areas such as scheduling, learning

management systems and workload distribution. On the student community side, there may also be some resistance, since an interdisciplinary course can challenge their expectations for a more passive learning process (Tharayil, 2018).

In spite of the fact that there is a particular and pressing societal need for interdisciplinary learning in science, technology, engineering, and mathematics (STEM) education there has been little change in STEM teaching at the post-secondary level (Cooke *et al.*, 2020). This is attributed to funding models, peer review systems (which devalue interdisciplinary contributions), academic promotion systems, physical location, and entrenched disciplinary perspectives and values (Anderson, 2010). Anderson's 2010 paper explains that there are also cognitive barriers towards interdisciplinary collaboration due to the domain specificity of scientific practice. These barriers consist of opacity of domain specific practices to outsiders, conflicting epistemic values, and large conceptual and methodological divides (Macleod, 2018). Wieman *et al.* (2010) observe that since scientists are inculcated in a system of organized scepticism, science departments can be particularly suspicious of change. Therefore, to accept change and to promote creativity and innovation, faculty members need an environment where they can discuss teaching as a serious scholarly activity, and where they can have a high level of autonomy and control within their course.

## Background to the development of the course

The interdisciplinary *Introduction to Forensic Science* course gives biology, chemistry, and physics faculty a high level of autonomy and space for pedagogical innovation, while providing a strong scaffold to support collaboration. The resilience and flexibility of the course comes from the individual freedom it allows for teachers willing to collaborate. This is one of the reasons it has been offered continuously for the past 15 years.

The course was first launched in Fall 2007. The initial suggestion was to design a level 1 complementary course, especially for students in the Criminology option of the Social Science program that was then being launched by the college. The course is intended to cement interest on the part of students by offering them a meta course that responds to their interest in forensics. The college wanted to offer courses that would provide legitimacy for the program by being specific to criminology, rather than offering generic courses with a criminology flavour. The initial pitch to the Science program committee was that the course be based on a crime scene that is examined from the perspective of the science disciplines.[1] This would give first semester students a reality check about what is needed for a career in criminology, by making it clear that while there are many career options in the field of criminology, Forensic Scientists are first and

[1] The teachers involved in the initial design of the course (William O'Leary, Nathalie Goulet and Justine Bell) contacted the Laboratoire de sciences judiciaires et de médecine légale (LSJML) in Montreal to help them better understand the nature of forensic work. They were given a personalized tour by LSJML director Yves Dufour, which helped them design the course, including the case study scenario.

foremost scientists with science degrees. In this regard, the public address to college students by an American crime novel writer, forensic anthropologist and academic is seen by Champlain College St. Lambert's Academic Dean, Dr. Anthony Singelis, as a trigger for the interdisciplinary course: "Author Kathy Reichs was probably instrumental in supporting this idea by giving a talk on campus. In her speech, she encouraged students interested in criminology to immerse themselves in the sciences and not ignore or fear them."

manifestation of a difficulty that led to an educational opportunity: "There were several challenges to designing the course. One was that team-taught courses offered by multiple disciplines had rarely been offered at the college. This was in part because the practice was not encouraged, but also because of the logistics involved. While the Science Program recognized that the multiple disciplinary approach permitted greater insight into a topic delivered by team members from different disciplines, they were concerned with the disadvantages, which included content overlap, potential conflicting messages relating to assessment, and the equal distribution of the workload."

**The resiliency and flexibility of the course comes from the amount of autonomy it gives to individual teachers.**

The gamble of such an interdisciplinary course was risky; however, the sustainability of this course shows that it has clearly been won. This course now distinguishes the Criminology option from any other similar program in the college system because it is firmly rooted in an authentic laboratory experience with teachers who are experts in their respective fields.

Initially, however, there were problems in determining which department should teach the course, mainly because of workload distribution issues. This brought about the idea to develop a multidisciplinary course, where all three Science departments (Biology, Chemistry, Physics) would participate equally. In Mr. Singelis' opinion, this can be seen as a concrete

The problem of epistemological differences between departments was addressed by dividing the 15 weeks into three five-week units. Each department would be autonomous for a five-week unit, and the students would rotate between teachers. To solve workload distribution issues, there would be three sections of the course, so that each teacher would have the equivalent of one complete section. This basic scheme was then refined to make it more interdisciplinary, so that there would be a two-week common introduction, establishing the unifying theme (objective evidence collection), which would be linked to a common final assessment in the last week. The plan was to have a common case study for all three units, but this has never yet been fully implemented.

## Interdisciplinary design and structure

In order to ensure the coherence and interdisciplinarity of the course while allowing for a certain degree of teacher autonomy, we had to consider two elements in its design. The first is a narrative arc, which in this course is about using the scientific method to gather objective evidence at a crime scene. The second is a unifying theme, which is a specific examination of the role of a forensic scientist providing objective, physical evidence to assist in a fair and just determination of a suspect's guilt or innocence. While the unifying theme is very important and facilitates teacher buy-in to a common vision for the course, the narrative arc, on the other hand, allows for a story to be told that engages students in the case study and in their learning throughout the session.

Both of these principles fit well with the course objectives of understanding the scope and approach of forensics in the study of a crime scene, and understanding, appreciating, and applying the basic elements of the scientific investigation process. Students learn the scientific method, the history of forensics and the role of modern forensic scientists, as well as discipline-specific forensic techniques such as DNA analysis, ballistics, etc. For science teachers, this is an opportunity to explore and convey a variety of approaches to scientific thinking and processes. The course

can accommodate different teaching styles, unplanned substitutions, and course interruptions. Teachers have the opportunity to implement their own pedagogical approaches without thwarting those of others, making the course a creative space for both innovation and collaboration.

The course is set up as shown in **Figure 1**, so that each teacher has one section for the first two weeks of the course. This teacher (Teacher A) is the main "home" teacher of that course for these students. During the two-week introduction, students are taught the history of forensic science, the scientific method, and the role of modern forensic scientists in crime investigation. At the end of the two weeks, students are given a quiz worth 5% of the final grade. This is also an opportune time to set students up into groups for the rest of the session.

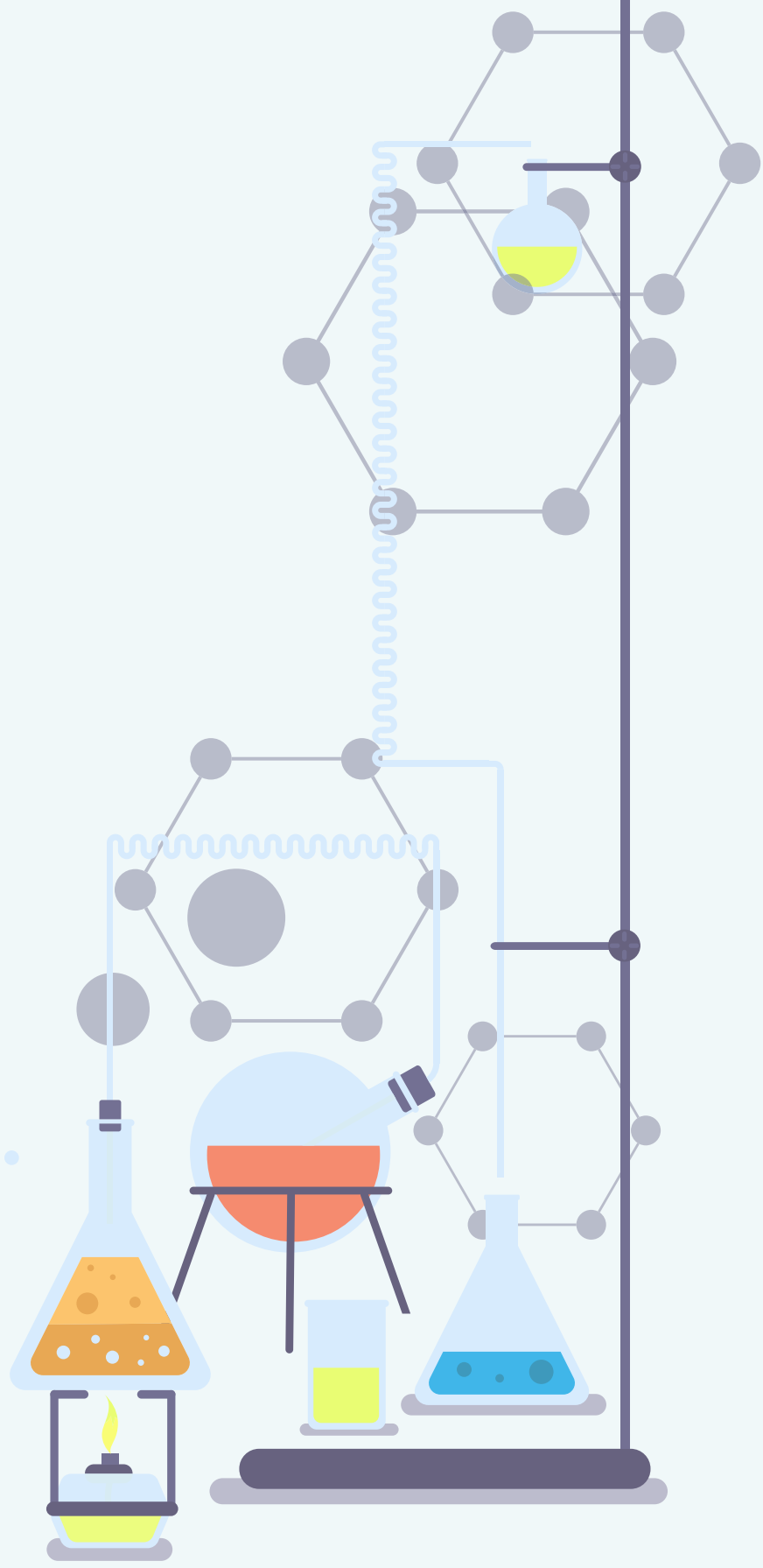


Figure 1

**General structure of rotation for the course *Introduction to Forensic Science***

| **Student Section I Home Teacher A** | **Student Section II Home Teacher B** | **Student Section III Home Teacher C** |
|---|---|---|
| **2 weeks, teacher A** General Introduction *Quiz* | **2 weeks, teacher B** General Introduction *Quiz* | **2 weeks, teacher C** General Introduction *Quiz* |
| **4 weeks, teacher B** Discipline B Unit Test B | **4 weeks, teacher C** Discipline C Unit Test C | **4 weeks, teacher A** Discipline A Unit Test A |
| **4 weeks, teacher C** Discipline C Unit Test C | **4 weeks, teacher A** Discipline A Unit Test A | **4 weeks, teacher B** Discipline B Unit Test B |
| **4 weeks, teacher A** Discipline A Unit Test A | **4 weeks, teacher B** Discipline B Unit Test B | **4 weeks, teacher C** Discipline C Unit Test C |
| **1 week, teacher A** Synthesis Asignment With Teacher A | **1 week, teacher B** Synthesis Asignment | **1 week, teacher C** Synthesis Asignment |
| **Total length = 15 weeks** | | |

evidence from the three disciplines to triangulate on a particular conclusion, within defined levels of uncertainty.

Such a model of interdisciplinary course rotation is easily transferable to other disciplines that would see pedagogical value and benefit in integrating knowledge from different disciplines to solve complex problems. The possibilities are numerous, and our experience suggests that such collaboration is possible and viable as long as it allows for a degree of autonomy for the teachers involved, which the model we have developed and refined over the years allows.

## Reflections from students

Feedback was solicited from students in the Fall 2021 semester using a voluntary and anonymous questionnaire. There were five questions in a yes/no explain format. The 47 responses were subjected to content analysis, the highlights of which we share here for the purpose of continuous improvement of the model we developed.

**Question 1**: *Did this course reinforce Criminology as the right program option for your studies?*'

93% of respondents who were in the Criminology program answered *"Yes."* Students mentioned that the course was interesting, and that it introduced the fundamental concepts of criminology. One respondent said: *"It shows a realistic and in a sense more mature aspect of the course. The covered content would most likely appear in the work that a criminology student would end up doing. For some, it would indicate if they wanted to pursue studies in this field."*

**Question 2**: *Did this course help give you insight about the role of forensic scientists as expert witnesses in trials (conducting tests, collecting and presenting evidence, and objectively explaining the techniques and conclusions to the general public)?*

94% of respondents answered *"Yes."* Students mentioned that they had better understood various aspects of the role of the scientific method for evidence collection, and that it helped them to better understand criminal investigation shows. One student stated: *"Techniques and real vocabulary were so useful and interesting. I can now understand police series."*

**Question 3**: *Did the use of a case study (the fictitious murder case in Seaway Park) help you to better understand the contribution of different branches of scientific evidence to forensics?*

62% of the respondents answered *"Yes,"* saying that it helped contextualize the material. One student reported: *"It did as we saw how many branches are actually needed for a forensics case. The use of a case study gave an insight into the importance of forensic science."* For the 36% who answered *"No,"* they found that the case study was confusing or not well linked with the material in the course. The ambiguity of the responses could be partially explained by the fact that the case study was not consistently referred to by all of the teachers in the course.

**Question 4**: *Did the multidisciplinary approach to this course help make it a more authentic representation of the contribution of science to criminology?*

83% of the respondents answered *"Yes,"* saying that they liked seeing the different aspects of forensic science. They enjoyed switching between teachers and appreciated the expertise of the teachers in their discipline. One respondent said: *"Although it may seem overwhelming, each discipline is intertwined, and some initial concepts can be found throughout them. This makes everything seem more manageable, whilst also giving the course a certain level of depth."* The 17% of students who answered *"No"* to this question said that they found it confusing and overwhelming to be continually switching teachers, and they felt that they did not have time to understand the material.

**Question 5**: *Is this a course that you would recommend to anyone wanting to study Criminology?*

96% of the respondents replied *"Yes."* These students said that they had found the course to be informative and enjoyable. They felt that the multidisciplinary aspect was unique and made it more interesting. Many students mentioned how much they enjoyed the lab work, and wished that there could be more of it. One stated: *"If you want to know what criminology is all about, this is the perfect class."* Another said: *"It is super interesting and you'll never get bored about what you are learning."*

## Conclusions and recommendations

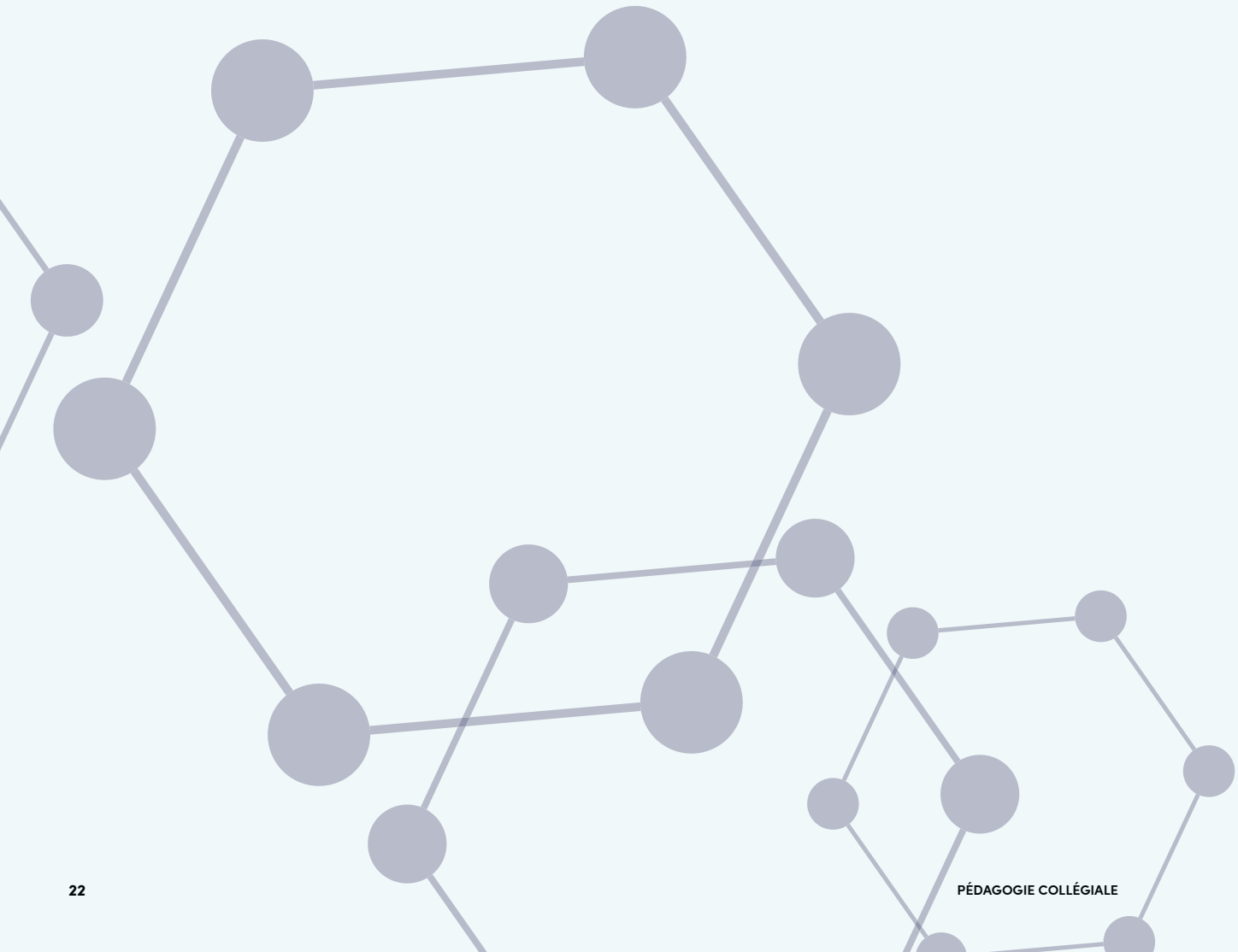
The course *Introduction to Forensic Science* has shown that it is possible to have a very successful and popular interdisciplinary approach to teaching a CEGEP course. The team-taught course has continued successfully and uninterruptedly for 15 years, in spite of changes in faculty and administration, and with new generations of students. It is innovative in its rotational design. It is a model for collaboration, in that teachers have flexibility and autonomy while working within a common framework, objectives and standards. It provides an authentic and real-world learning experience in a field that students are interested in pursuing as a career. The three different teachers from different science disciplines reinforce the concept of the scientific method, and establish the importance of critical thinking and objective evidence collection.

In spite of the course's longevity and success, there have been challenges for teacher collaboration. One issue is the failure to persuade all three teachers to adhere to the same case study model. This can be attributed to a deficit in the initial setup of the course, where expectations for teachers in terms of procedures and responsibilities were not delineated clearly enough. A course such as this one must have a very explicit theme and story arc, and this must be frequently and explicitly referenced throughout the course. The first two weeks and the last week of the course are very important in

helping the students integrate the three disciplines, and all three teachers must agree to be especially closely aligned for these two parts of the course.

The first three of The Ten Commandments of Collaborative Teaching outlined in 2006 by Joshua Landy and Lanier Anderson (Palmer, 2006) are that teachers need to plan together, attend each other's classes, and refer to each other's classes. The institution has an important role in finding ways to make it easy for the teachers to communicate and do these things, as the teachers need help in connecting across departmental barriers. One important factor concerns the learning management systems that has to be adapted to fit a multi-disciplinary course. The administrators have to be actively engaged, particularly when passing responsibility for one group of students from one teacher to another.

An important lesson from this course is the value of giving teachers autonomy so that they can be creative and innovative. The framework of the course should be well defined, but should not be too constraining. All departments involved need to be invested and supportive of the course, and this is only possible if it is not perceived as a threat to the different departmental cultures. This type of course can be viewed as a powerful forum for intellectual exchange and scholarly discussion, which is inspiring and motivating for teachers, and helps in understanding the role of their discipline within their program. ▬



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