



Mathematics Teacher Educators' and Pre-Service Teachers' Beliefs about the Use of Technology in Teaching in an African University

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ABSTRACT

This study examines beliefs held by mathematics teacher educators and pre-service teachers about the usefulness and teacher educators' belief on ease of use of computers in teaching in an Ethiopian teacher education University. It also identifies teacher educators' actual practices in using computers in teaching. The study used questionnaires and semi-structured interviews to collect data from 15 mathematics teacher educators and 42 pre-service mathematics teachers. The data was subsequently analyzed through the lens of Davis' (1989) modified Technology Acceptance Model (TAM). The TAM approach focuses on how the external domain, such as professional development (PD), and accessibility of technology, influences participants' beliefs about the usefulness, and ease of use of technology, which in turn impacts their actual use in teaching. The results of this study found that although the participant teacher educators and pre-service teachers held positive beliefs about the use of computers in teaching, these beliefs were not positively related to the teacher educators' actual practices. The teacher educators did not often use technology in their teaching. The study identified a number of external factors which may have impeded the teachers' use of technology, including accessibility and professional development on integrating technology in the classroom.

Keywords: computer usefulness, computer eases of use, teacher educators, pre-service teachers

INTRODUCTION

There is growing interest in African higher education in relation to the use of computers to support learning (Bass, 2007; Harrison, 2010). Computer and Internet applications are increasingly making their way into teaching. Research (e.g., Ayub, Mokhtar, Luan, & Tarmizi, 2010; Su, 2008; Voogt, 2008) has shown that the use of technology, particularly computers and computer peripherals, in teaching generally improves the quality of teaching. Accordingly, many African countries are encouraging teachers to use computers in their teaching and formulating policies for effective practice (Harrison, 2010). As a result, the use of computers in African education system is increasing, with the aim of improving the quality of education (e.g., Harrison, 2010; Ottevanger, Akker, & Feiter, 2007).

The current Ethiopian school curriculum and education has been characterized as low in quality (e.g., Belihu, 2010; Desta, Chalchisa, Mulat, Berihun, & Tesera, 2009). There is considerable support throughout the Ethiopian education system, including the Higher Education sector, for programmes to improve the quality of education. It is with this in mind that the Ethiopian Ministry of Education (MOE) launched “The National ICT’s in Higher Education Initiatives (MOE, 2010). This National Initiative encourages all teachers including teacher educators to use technology in all spheres of their teaching in order to raise the standard of education. The policy advocates the use of technology as a means to improve the quality and equity (equity is specially aimed at secondary schools) of education, particularly for science and mathematics teaching. The emphasis on science and mathematics accords with the government’s ‘70:30’ policy (which has the objective of 70 % of university students enrolling in science and mathematics courses). The National Initiative is also supported by programmes such as the Education Sector Development Programs (ESDP) to enhance the quality of learning in science and mathematics through the use of technology in teaching. However, the actual use of technology in teaching is influenced by a number of variables. This study considered the influence of several external factors (accessibility of technology, teachers’ PD in relation to integrating technology) as well as teachers’ and students’ beliefs about the usefulness and teachers’ beliefs on ease of technology in teaching. According to Davis (1989), beliefs about computers’ usefulness and ease of use has an influence on teachers’ motivation to use computers the classroom, and later affects teachers’ actual use of technology in their own teaching practice. As such, the beliefs that are held by teachers’ and students’, influences actual practices in the classroom in teaching technology-integrated lessons (Higgins & Moseley, 2001). In light of these matters, this study was proposed to answer the following research questions:

1. What beliefs are held by mathematics teacher educators and pre-service teachers about the usefulness of computers, and what beliefs are held by those teacher educators about the ease of use of computers?
2. Is there a difference in teacher educators’ and pre-service teachers’ beliefs about usefulness of computers?
3. What are the actual practices of mathematics teacher educators in using computers in their teaching?

BACKGROUND

The success of initiatives to implement technology in educational programmes depends strongly upon beliefs of teachers involved (e.g., Ma, Andersson, & Streith, 2005; Wozney, Venkatesh, & Abrami, 2006). A review of the literature suggests that the integration of technology into teaching and learning is typically affected by teachers’ technology skills, gained through PD, and teachers’ technology beliefs (Hew & Brush, 2007). Ertmer (2005) argues that the decision regarding whether to use technology for instruction ultimately depends on the teachers themselves and the beliefs they hold about the usefulness of the technology.

Research indicates that teachers’ beliefs about the usefulness and ease of use technology are linked to the actual use of computers in teaching (e.g, Ma et al., 2005; Park, 2009). Zhao, Tan, and Mishra (2001) provide evidence to suggest that the beliefs of teachers about the usefulness of technology/computers are directly related to computer use in the classroom. In addition, studies show that belief influences the capacity of teachers, to teach in general, and to integrate technology into their teaching in particular (Albion, 1999; Higgins & Moseley, 2001; Li, 2003). For example, Higgins and Moseley (2001) suggest that

the beliefs that teachers hold, directly affect both their perceptions and practices of teaching and learning interactions in the classroom, and that these, in turn, affect their teaching. The research conducted by (Ma et al., 2005) indicates that pre-service teachers' perceptions about the usefulness of computer technology has a direct and significant effect on their intention to use it. Further, Albion (1999) proposes that there are multiple external factors which can influence teachers to integrate technology in their teaching including the accessibility of hardware and relevant software, the nature of the curriculum, personal capabilities gained through PD and constraints such as time, however, teachers' beliefs in their capacity to work effectively with technology are nonetheless seen as a significant factor.

Teo (2008) has reported that teachers' and students' beliefs about using technology are a pivotal variable, influencing the integration of computers into teaching. A basic assumption in this regard is that computers will work for the benefit of students, as well as improve the professional performance of teachers. Hence, teachers' beliefs concerning the usefulness of technology and its ease of use may provide valuable insights into technology integration and acceptance and usage of technology in teaching and learning.

This literature indicates those external factors, as well as teacher educators' beliefs about the usefulness and ease of use of technology, impact on teachers' motivation, which in turn influences their actual practice in the classroom. In addition, students' beliefs about the usefulness of computers on teaching are also important. In order to investigate and describe this relationship a modified Technology Acceptance Model (TAM) (Davis, 1998) is used. Operation of the model is illustrated in Figure 1.

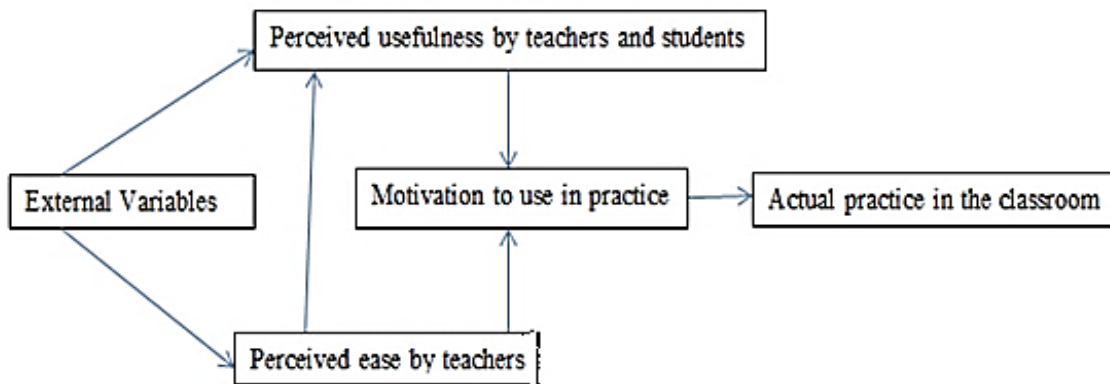


Figure 1: Modified Technology Acceptance Model (Davis, 1989)

Davis (1989) and Davis, Bagozzi, and Warshaw (1989) suggest that users' motivation to utilise technology in the classroom, which in turn leads to their actual practices in the classroom, can be explained by the external variables: perceived usefulness and perceived ease of technologies. The following definitions of these concepts are used in the context of this study.

Perceived usefulness - The degree to which a user of a particular technology believes that using a particular technology would enhance teaching performance. This definition suggests that when a technology is perceived as being useful, a teacher or a student will have a more positive attitude toward it, which encourages its subsequent use in practice.

Perceived ease of use - The degree to which a teacher believes that using a particular technology would be easy and free from effort, which encourages its subsequent use for teaching purposes. In this case, perceived ease of use can help to promote a teacher's beliefs about the usefulness of a technology.

External factors - This model also proposes that external factors (e.g., PD and accessibility of technology) affect intentions and actual use through mediated effects of perceived usefulness and ease of use (Davis, 1989).

Generally, TAM suggests that external factors, teachers' and students' beliefs about the usefulness and ease of use of a particular technology, are major decisive factors in relation to teachers' actual practice (Davis, 1989). In this study, external factors, the participants' beliefs about the usefulness and ease of use of technology are examined in order to determine the applicability of the model, in the context of an Ethiopian teacher education university.

METHOD

The study employed both qualitative and quantitative approaches to describe and investigate the beliefs held by mathematics teacher educators and their pre-service teachers about the use of computers in teaching and teachers' actual practices in their teaching. The data were analysed and discussed through the lens of Davis' (1989) modified TAM. This model focuses on how matters within the external domain (such as PD involvement, and accessibility of technologies) affects participants' beliefs (usefulness, and ease of use) about technology, and whether those beliefs, in turn, influence their actual use of technology in their teaching. The model was also used to investigate the consistency of teachers' actual use of technologies in their teaching, with their beliefs about usefulness and ease of use.

Instrument

The study employed two forms of a questionnaire, as well as semi-structured interviews, to collect the data. The semi-structured interviews were conducted with five mathematics teacher educators about usefulness of technology, factors influencing their use of technology, and their actual practices. The questionnaire was developed based on the research questions of the study and a review of relevant literature. Content validity of the two forms of the questionnaire was established by a pilot test of with 3 teacher educators and 10 pre-service teachers. The questionnaire was designed to measure teachers' and students' beliefs about the usefulness, and ease of use, of computers and computer peripherals. It also included items to investigate teacher educators' actual practice in the classroom. The questionnaire contained open-ended questions and Likert-scale questions; it was distributed to 15 mathematics teacher educators and 42 pre-service mathematics teachers. The questionnaire given to the teacher educators consisted five different parts. Part I asked about demographic data of the participants including age, teaching experience, qualifications and gender. Part II contained questions about the teacher's perceived ease of use of computers, based on a scale of [1= I have a good experience on it, 2= I have some experience on it, 3 = I have limited experience on it and 4 = I have no experience on it or I don't know.] Part III concerned the teacher's beliefs about the usefulness of using computers in teaching, using a scale of 1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree and 5 = undecided. Part IV addressed the mathematics teacher's actual practice in teaching with technology measured by a scale of 1 = very often, 2 = often, 3 = sometimes, 4 = seldom and 5 = never. Finally, Part V was an open-ended question which asked the teacher to explain and list factors which influence his or her use of technology in teaching.

The questionnaire distributed to pre-service teachers consisted of only two parts. Part I contained questions related to demographic data including age and year in the university. Part II asked about the usefulness of computers in learning (similar to the Part III of teacher educators' questionnaire).

Data analysis

Descriptive statistics were applied to evaluate and describe teacher educators' actual use and beliefs about the usefulness and ease of use of technology in teaching. The descriptive analysis was also used to describe pre-service teachers' perceptions about the usefulness of technology. Paired sample *t*-tests were used to analyse the existence changes in perceived usefulness of technologies between teacher educators and pre-service teachers. A series of one-way analysis of variance (ANOVA) tests for the entire sample was conducted in order to identify the location of difference in perceived usefulness of technologies. Statistical Package for Social Science (SPSS) applications were used to calculate the descriptive statistics and mean differences including *t*-tests. Attempts were also made to triangulate the data gathered from questionnaires and interviews.

RESULTS

Demography

A total of 57 participants were involved in the study, consisting of 15 mathematics teacher educators and 42 pre-service teachers. Most of the teachers had worked for more than 3 years in teacher education institutions (N = 9) with the remainder having had between 2 and 3 years (N = 6) experience. Most of the teacher educators (N = 11) had not received any PD related to the use of technology in teaching. The pre-service teachers who participated in the study were in their 2nd (N = 20) and 3rd years (N = 22) of study; the 3rd years students were ready to graduate as secondary school mathematics teachers.

Overall beliefs of participants about the usefulness of computers in teaching

Participants were asked to place themselves on a continuum from 1 (strongly agree) to 5 (undecided) with regard to their beliefs about the usefulness of computers for teaching and learning mathematics. Teacher educators strongly agreed with the proposition that computers can improve the quality of mathematics teaching (M = 1.21, SD. = 0.41) while pre-service teachers agreed that computers can improve the quality of mathematics teaching (M = 1.64, SD. = 0.82). In addition, both the teacher educators and the pre-service teachers indicated that they believed computers should be introduced in mathematics teaching (M = 1.73, SD. = 1.03 and M = 1.20, SD. = 0.40), as indicated in Table 1. The total results indicate that teacher educators and pre-service teachers consistently agreed on the usefulness of technology/computers in teaching and learning of mathematics (M = 1.61, M = 1.46).

Table 1: *Teacher educators' and pre-service teachers' belief on usefulness of computer and peripherals*

Items	Teacher educators N = 15		Pre –Service Teachers N = 42	
	M	SD	M	SD
Computers can improve quality of mathematics teaching	1.21	0.41	1.64	0.82

Computers can provide self-paced learning	1.60	1.06	1.72	0.75
Internet can provide collaborative learning	1.40	1.06	1.33	0.72
Computers can provide equal opportunity to learners	2.13	1.06	1.20	0.46
Online learning resources help for self-empowerment	1.47	0.83	1.46	0.83
Computers can help pre-service teachers to learn better	1.60	1.06	1.60	0.90
Computer-based tutorials can improve learning	1.80	0.86	1.48	0.83
Computer-based simulations can improve learning	1.53	1.06	1.27	0.50
Curricular-based software should be incorporated	1.73	1.03	1.52	0.74
Computers should assist mathematics teaching	1.53	0.83	1.50	0.94
Computers should be introduced in mathematics teaching	1.73	1.03	1.20	0.40
Computers should assist higher education	1.53	1.06	1.59	1.02

Paired sample *t*-tests comparing teacher educators' and pre-service teachers' beliefs on the usefulness of computer in teaching mathematics were conducted and showed a consistent result as to positive beliefs about the usefulness of technology, with the exception of the significant positive mean differences on the items set out in Table 2.

Table 2: *Mean differences between teacher educators' and pre-service teachers' beliefs about usefulness of computers in teaching*

Items	Mean Difference	Sig.
Computers can improve quality of mathematics teaching	0.44	.051
Computers can provide self-paced learning	0.13	.626
Internet can provide collaborative learning	0.07	.798
Computers can provide equal opportunity to learners	0.94	.000*
Online learning resources help for self-empowerment	0.03	.989
Computers can help pre-service teachers to learn better	0.00	1.00
Computer-based tutorials can improve learning	0.32	.206
Computer-based simulations can improve learning	0.27	.209
Curricular-based software should be incorporated	0.21	.402
Computers should assist mathematics teaching	0.03	.904
Computers should be introduced in mathematics teaching	0.54	.006
Computers should assist higher education	0.05	.878

*significant at $\alpha = 0.005$

Even though both groups of participants reported common agreement on “Computers can provide equal opportunity to learners”, the teacher educators only ‘Agreed’ with the item ($M = 2.13$), whereas the pre-service teachers ‘Strongly Agreed’ ($M = 1.20$). Consequently the results showed a significant mean change ($M = 0.94$).

Teachers’ perceptions of the ease of use of technology in teaching

The other variable considered in this study was perceived ease of use of technology by teacher educators. To describe and evaluate perceptions about ease of use, teacher educators were asked to rate themselves on a scale of 1 (I have good experience with it) to 4 (I have no experience with it or I don’t know). The results are set out in Table 3.

Table 3: *Perceived ease of selected technologies by teachers*

Items (N = 15)	M	SD
Using word-processing applications like Microsoft Word	1.1	0.63
Using spreadsheet applications like Microsoft Excel	1.2	0.86
Using database systems like Microsoft Access	2.8	0.15
Using email	1.1	0.13
Using search engines	2.0	0.22
Using online learning materials	1.5	0.39
Using educational CD-ROMs like Encarta encyclopaedia	1.7	0.93
Using for Management Systems to manage your files	2.5	0.12
Web page development	3.1	1.03
Publishing a web page	3.3	1.04

As indicated in Table 3, the mathematics teacher educators reported having had good experiences with using word processing applications in teaching ($M = 1.1$, $SD = 0.63$). In contrast, they had limited experience in using publishing web page applications and using file management systems in their teaching ($M = 3.2$, $SD = 1.03$). In general, the teacher educators had some degree of experience across all the listed items ($M = 2.03$).

Actual use of selected technology in teaching

A detailed analysis of teacher educators’ actual use of technology in their teaching is provided in Table 4.

The data on the actual practices of teacher educators, in using technology in their teaching, reveals that the participants’ use of technology to teach is limited ($M = 3.78$).

Table 4: *Actual use of selected technologies by teacher educators*

Items (N = 15)	M	SD
Providing lessons with PowerPoint slides	4.2	1.47
Using Word Processing applications	3.8	1.57

Using spreadsheet applications	3.9	1.39
Using educational CD-ROMs	3.9	1.60
Using email for academic matters	3.9	1.68
Using online learning materials	3.7	1.59
Using LAN for Collaborative work	4.4	1.33
Using Computer based Simulation and/or games	3.5	1.64
Using Computer based Tutoring	4.1	1.41
Using courseware authoring tools	4.3	1.44
Using Learning Management Systems	4.4	1.45
Using the Internet as the main source of materials	1.2	1.62
Using computer for teaching purpose	3.8	1.42

Qualitative data

Teachers' beliefs about the usefulness and use of ease of technology in teaching

Semi-structured interviews were conducted with 5 mathematics teacher educators to investigate their beliefs on the usefulness and ease of use of technology in teaching, and factors which influenced their use of technology to teach mathematics. The questions about beliefs regarding the usefulness of technology included: "Do you believe that computers can improve your teaching?" In answering that question, one of the participants provided the following response -

I believe that computers are helpful to facilitate teaching, however, it seems difficult to use in teaching mathematics (Participant -5).

This response reflects the general views expressed by the teacher educators who were interviewed. In the course of discussing this topic, several of the teacher educators also mentioned multiple factors which might make it difficult to use computers in mathematics teaching.

During the interviews, some of the teacher educators also argued that computers could reduce students' mental engagement. For example, one teacher commented -

Computers are helpful to cover broad contents in a short period of time (Participant -3).

This view is at odds with the belief held by other teacher educators who felt that computers should be introduced and used intensively in the teaching of mathematics to facilitate learning.

One participant described his experience of using computers to teach mathematics in the following way -

I have used spreadsheets to teach calculus while I was teaching to determine the area of a curve. The lesson was fantastic and pre-service teachers were motivated and engaged in the classroom (I4).

Others supported the importance of including such technologies in mathematics teaching to actively involve the students and open the way for the students' future use of technology in teaching mathematics in secondary schools. One participant emphasised the importance of using technology in mathematics teaching by saying -

We often ignore the importance of technology as other factors muddled us to see the beauty of technology in facilitating learning (Participant -2).

Most teacher educators were confident that they could easily learn new technology and integrate it into their mathematics teaching. However, the interview participants also identified a number of factors which might prevent teachers from realizing and appreciating the importance of using technology in mathematics teaching. These factors are discussed in the next section.

External factors influencing teachers' actual use of technology in teaching

The qualitative data collected for the study indicated that the participants' actual use of technology in teaching is influenced by two major external factors. These factors are the accessibility of technology, and the professional development which had been undertaken by the teacher educators.

Accessibility of technologies

The results of this study show that a number of factors may inhibit the use of technology in mathematics teaching. Such factors include: (i) limited inventory of technology items, like computers, software, LCD projectors and overhead projectors, (ii) limited connectivity to the Internet (and even when connectivity is satisfactory the number of connected computers may be limited), (iii) limited number of computer centres/labs for pre-service teachers. Most participants reported that they had a computer with connectivity to the Internet, and several suggested that there were sufficient computers available provided teaching followed the scheduled programme. On this point one participant noted -

Even though, most of us complaining accessibility of technologies to integrate in our teaching, I believe that the accessibility would not be a problem at all. The available technologies are sufficient if we are able to use them in a scheduled and programed structure. Rather other factors like insufficient PD influenced us to use technologies in our teaching.

Teacher professional developments practices

The majority of the teacher educators reported that they had received no PD related to teaching on the use of technology (N = 11). Only a few teacher educators (N = 3) had been involved in such PD. If a teacher lacks the necessary skills and knowledge relating to the use of technology in teaching, precious instruction time can be wasted. Accordingly, teacher educators should be supported through PD to gain the necessary skills and knowledge to enable them to use technology in their teaching.

DISCUSSION

This study examined the beliefs of Ethiopian mathematics teacher educators and pre-service teachers about the usefulness and teacher educators ease of use of technology in mathematics teaching, as well as teacher educators' actual practices in teaching using technology. Further analysis was conducted to explore the relationship between teacher educators' beliefs about the use of technology in teaching mathematics and the participants' experience in their teaching. Factors which might influence teacher educators' practices in teaching mathematics were also investigated.

Both the teacher educator and the pre-service teacher participants expressed positive beliefs concerning the usefulness of technology in the teaching of mathematics. Such beliefs represent a favourable pre-condition for teachers to utilise technology in their teaching practice (Albion, 1999)]. Both groups supported the introduction of technology into mathematics teaching as a means to increase teaching quality. This is important as it has been shown that positive beliefs held by teachers directly affect their teaching (Higgins & Moseley, 2001). Interestingly, there was consistency of beliefs, between

the teacher educators and the pre-service teachers, on the importance of technology in the teaching of mathematics. This further supports the idea that technology should be used in teaching (Ma et al., 2005). The majority of the teacher educators expressed a view that technology can encourage active learning and engagement on the part of pre-service teachers; however, there were a number of teachers who considered that the use of technology in mathematics teaching might diminish the mental engagement of students. This opinion may have been based on the assumption that the integration of technology could change the content of instruction. In this regard, research indicates that technology can magnify the content, to assist students to understand its meaning, rather than affecting the content (e.g., Adams, 2011; Inder, 2010).

The data was further analysed to establish whether there was a relationship between positive beliefs on the part of teacher educators, and their actual practice of using technology in teaching. A number of studies (e.g. Ma et al., 2005; Park, 2009) indicate that favourable beliefs about the usefulness and ease of use of technology are positively related to actual use of technology in practice. However, in this study, the findings show that, even though the teacher educators held positive beliefs about technology, they seldom used such technology in their teaching. This finding contrasts with previous studies (e.g., Albion, 1999) which indicated that positive beliefs influence teachers' classroom practice. The difference in outcome in this research may have been influenced by other factors including the teacher educators' lack of PD on integrating technology into classroom practices. On this point, research consistently demonstrates that technology alone does not have a significant effect on teaching, but rather the teacher's skills and knowledge, gained through PD, play a pivotal role in its effectiveness (e.g., Cradler, McNabb, Freeman, & Burchett, 2002). This aspect was also addressed by the teacher educators during the interview phase of the study. For example, a participant revealed –

We often ignore the importance of technology as other factors muddled us to see the beauty of technology in facilitating teaching (Participant - 2).

The importance and relevance of PD as a decisive factor, together with beliefs concerning the usefulness and ease of use of technologies, should not be overlooked when considering the integration of technology into classroom teaching.

In summary, this study has shown that the participant mathematics teacher educators and pre-service teachers held positive beliefs about the usefulness and ease of use of technologies in teaching. Such beliefs are consistent with the government policy on the use of technology in teaching, which has been adopted by the Ethiopian University as means to improve quality. However, the level of relevant PD and other external factors (e.g., accessibility of technology) are likely to affect the implementation of the policy. Further research should be conducted to describe and evaluate the relationship between and among external factors (e.g. PD) and beliefs on usefulness and ease of use of technology for teacher educators' actual practices in teaching.

CONCLUSION

In this study, it was established that participant teacher educators and pre-service teachers held positive perceptions about the usefulness of technology in teaching mathematics. In addition, the teacher educators were confident that they could learn about technology easily. Previous studies consistently conclude that positive beliefs about the usefulness and ease of use of technology are favourable indicators for actual teaching practices. In this study, however, such beliefs did not provide a positive guide to actual classroom practices. Other factors, such as PD concerning the integration of technology into teaching, and the accessibility of technologies may also have influenced the teachers' behaviour. This study found that positive perceptions about the usefulness and ease of use of technology did not

guarantee a teacher's actual practices in teaching; rather, external factors also played a vital role, particularly the PD received by the teacher.

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