Sign Language Mathematics Lecture Video as Assistive Technology for Inclusive Class in Higher Education

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Abstract

This research was motivated by the acceptance of one deaf student in the Department of Computer Science UNNES in the 2020/2021 academic year. Therefore, this research aims to provide the study with efforts to increase the absorption of deaf students in the inclusive class through the discovery of Assistive Technology. The method used in this research is Mixed Method with a qualitative and Research & Development (R&D) approach. Data collection includes class observations, interviews, triangulation of results, and stages of R&D. Research activities include: (1) lecturer of mathematical courses made PPt files, filled in Lecturer's Voice, and filled in Sign Language. (2) Video tested in inclusive class. (3) Finalization of Assistive Technology Videos and the results were noted. Research Results: (1) multi-function video prototypes were obtained for deaf students in inclusive classes in mathematical courses. (2) There was an increase in the activity and absorption of students in the inclusive class. In conclusion, it is necessary to make assistive technology in the form of learning videos that contain sign language to increase the absorption of deaf students in the inclusive class in mathematical courses.

Keywords: Assistive Technology; Multi-Function Videos; Inclusive Class

Abstrak

Penelitian ini dilatarbelakangi telah diterimanya satu mahasiswa Tunarungu pada Jurusan Ilmu Komputer UNNES pada tahun ajaran 2020/2021. Oleh karena itu tujuan penelitian ini adalah memberikan kajian upaya meningkatkan daya serap mahasiswa Tunarungu di kelas Insklusif melalui penemuan Teknologi Asistif. Metode dalam penelitian ini menggunakan metode mixed method dengan pendekatan kualitatif dan Research & Development (R&D). Pengumpulan data meliputi; observasi kelas, wawancara, triangulasi hasil, dan tahapan R&D. Kegiatan penelitian meliputi: (1) dosen pengampu mata kuliah matematis membuat file PPt, diisi suara dosen, dan diisi Bahasa Isyaratnya. (2) Video diujicobakan di kelas Inklusif. (3) Finalisasi video Teknologi Asistif dan dicatat hasilnya. Hasil penelitian: (1) Diperoleh Prototip video Multi-Fungsi untuk mahasiswa Tunarungu di kelas Inklusif pada mata kuliah matematis. (2) Ada peningkatan aktivitas dan Daya Serap mahasiswa di kelas Inklusif. Kesimpulannya: Untuk meningkatkan daya serap mahasiswa Tunarungu di kelas Insklusif pada mata kuliah matematis, perlu dibuat Teknologi Asistif berupa video pembelajaran yang berisi Bahasa Isyarat.

Kata Kunci: *Teknologi Asistif; video Multi-Fungsi; Kelas Inklusif*

INTRODUCTION

Necessary Ideal Conditions

Law Number 8 of 2016 Article 42 requires universities in Indonesia to be able to provide good services to students with disabilities. It is explained in Regulation of Minister of Research, Technology, and Higher Education Number 46 of 2017, that the government provides the widest opportunity for students with special needs or students with disabilities to be able to receive education in higher education.

Semarang State University (UN-NES) is a university in Central Java that has been accredited A. In the 2020/2021 academic year, the Department of Computer Science at the Faculty of Mathematics and Natural Sciences (FMIPA) UNNES has accepted one disabled student who is deaf. Thus, ideal conditions are needed for a lecture that is beneficial for Inclusive Classes. The ideal conditions in question are ideal lecture conditions for deaf students in inclusive classes that are still under current regulations in higher education and do not conflict with applicable laws or regulations. The ideal condition required is an ideal lecture service for deaf students with the development of a multi-function assistive technology media that is useful for deaf students and regular students, which can be used in one inclusive class (*das Sollen*). On the other hand, the fact (*das Sein*) is that lecturers in the Department of Computer Science are not ready and do not have the experience to provide the best service in teaching students who have hearing impairments or are deaf. The reason is that the Department of Computer Science has never accepted students who have hearing impairments or are deaf. As a result, it is reasonable that Computer Science lecturers do not have experience conducting lectures for deaf students mixed with regular students. Lecture classes whose students are a combination of regular students and the ones with disabilities are called Inclusive Classes. This means that there is a gap that needs to be bridged between *das Sein* and *das Sollen*. The solution is assistive technology media in the form of multi-function video. With this assistive technology, deaf students in their lectures can pay attention to lecture material in the form of PPt and lecturer explanations translated into Sign Language (BISINDO). On the other hand, regular students in their lectures can pay attention to PPt material and lecturer explanations. Thus, regular students do not feel disturbed by the presence of deaf students in this inclusive class. It is hoped that the absorption of deaf students and regular students can be improved.

Based on the preliminary interview between this researcher and the Deaf students, it was proven that: (1) The deaf students have attended an extraordinary school since childhood and understand the ordinary written language; (2) Because these students have studied since childhood in an Extraordinary School, they have mastered Sign Language which in Indonesia is known as BISINDO. BISINDO stands for Bahasa Isyarat Indonesia (Indonesian Sign Language); (3) After being accepted as UNNES students through a series of Entrance Tests to State Universities, these students liked and felt comfortable with lecture content at the Computer Science Department, FMIPA UNNES, in the Information Systems Study Program; (4) They are hoping for the existence of lecture media, especially mathematical ones, in the form of assistive technology that makes them able to grasp lecture material well; and (5) They also hope that there will be a lecture system equipped with Sign Language.

Thus, researchers began to take steps to design, create, and develop a mathematical assistive technology media that is expected to be used together in one class that can be utilized by both regular and deaf students.

Based on the written interview with the deaf students, the researchers conducted a series of FGDs and resulted in a decision to design, create, and develop an assistive technology media in the form of making a video containing mathematical lecture material filled with lecturer explanations and filled with Sign Language. Furthermore, it is designed so that the resulting video can be made using the Learning Management System (LMS) link owned by UNNES. The LMS link owned by UNNES is called Elena. Through Elena, students can discuss in writing and upload assignments from the lecturer to be read, corrected, commented on, and assessed by the lecturer in charge of the course.

As a prototype, the multi-function videos that will be produced are expected to be applied in a lecture in this inclusive class, which are expected to: (1) have an element of novelty, (2) be practical and easy to use, for inclusive education in a lecture, and (3) is useful for increasing the absorption of the lecture material for deaf students.

Research Objectives

The objectives of the research carried out through the design and production of Assistive Technology are: (1) To develop Assistive Technology for deaf students in the Department of Computer Science, FMIPA (Faculty of Mathematics and Science) UNNES through interactive multi-function videos prototypes. (2) Produce prototypes of Assistive Technology for Deaf students in the Department of Computer Science, FMIPA UNNES

through interactive multi-function videos that can be applied inclusively in a lecture. (3) Obtaining a scientific study of the absorption capacity of Deaf students in the Department of Computer Science, FMIPA UNNES after using the prototype of Assistive Technology in the form of interactive multi-function videos.

Needs Analysis

Needs analysis is necessary and urgent to hold the resulting Assistive Technology Development. This needs analysis based on the students' interests. According to English & Halford (1995), learning actions taken by lecturers must be based on the needs and interests of their students. This is also following the opinion of Ernest *et al.* (2016) which states that mathematical-based learning actions taken by lecturers need to be able to serve all types of student interests. Analysis of the needs is as follows: (1) Semarang State University (UNNES) as a university in Central Java that is accredited A, in the 2020/2021 academic year, has accepted one disabled student who is deaf at the Department of Computer Science, FMIPA UNNES; (2) Based on the interview between researchers and deaf students, it is known that the students have attended special schools since childhood; (3) After being accepted as UNNES students through a series of Entrance Tests to State Universities, these students liked and felt comfortable with lecture content at the Computer Science Department, FMIPA UNNES, in the Information Systems Study Program; (4) These deaf students hope that there will be lecture media in the form of assistive technology that makes deaf students able to grasp lecture material well, for example, a lecture media equipped with sign language or BISINDO (Bahasa Isyarat Indonesia); (5) On the other hand, these students

want to continue to join classmates in every lecture. This means that the lectures that take place are an Inclusive Education System.

Expected Benefits

The expected benefits of the development carried out through Assistive Technology are as follows: (1) So that students with disabilities who have been registered at UNNES feel well served and can complete their studies properly; (2) If other students have disabilities and will study at UNNES, they will feel guaranteed that they will be served well and can complete their studies properly.

Deaf Students

Mudjiyanto (2018) and Sugiman (2022), wrote that deafness can be interpreted as a state of hearing loss that results in a person not being able to catch various stimuli, especially through the sense of hearing. Many experts have put forward the definitions of deaf people, all of which contain the same meaning, as mentioned above.

Based on the opinion above, it can be interpreted that the deaf (hearing impairment) is one of the general terms that show the inability to hear from the mild to severe which is classified as deaf and less heard. Students who are deaf are students who experience a disability to hearing so they experience obstacles in processing lecture material or language information through their hearing.

The Need for Deaf Students to Adapt to Lectures

If deaf students attend lectures with an inclusive education system, deaf students must be able to adapt to the learning of regular students. The ability to adapt is one of the non-cognitive skills that students demand to be ready to face the 21st-century era. Ebenehi *et al*. (2016) and Collie & Martin (2016) wrote that the ability to adapt is the ability to make adjustments. If the deaf students are unable to adjust, they can easily be discouraged, tortured, or not be able to continue their studies.

Next, Akkermans *et al*. (2018) wrote that the characteristics of self-adjustment (adaptability ability) in deaf students are as follows. (1) Able to control self-emotions. (2) Having patience in dealing with problems that occur. (3) does not accentuate the frustration disorders in them. (4) have rational considerations so that all the decisions they make are from rational thoughts. (5) Being able to behave realistically and objectively so that whatever events occur are seen as a realistic and objective thing.

The curiosity of Deaf Students about Computer Science

Deaf students entered UNNES by choosing the Department of Computer Science, Information System Study Program. Of course, it was also encouraged by the curiosity of these deaf students to explore the computer field. A curiosity of deaf students about computer science must be developed from the start because this will be a steppingstone for students to find out many things about themselves or their environment. According to Menning (2017) and Zurn & Bassett (2018), curiosity will also be a foundation in facing and solving problems. Strategies that lecturers can do in developing the curiosity of students in the computer field, among others: train students to dare to ask, allow students to love reading, and train students to tell each other about the lecture books they read. Lecturers or Study Programs need to facilitate assistive technology to facili-

tate deaf students in attending inclusive lectures.

Characteristic of growing curiosity of students according to Kashdan *et al.* (2018), is a student like or brave in: (1) asking outside the textbook about material related to basic lectures, (2) reading sourcebooks outside the textbook about material related to lectures, (3) discusses the material related to lectures, or newly heard technology, 4) put forward their opinions, about material related to lectures, and (5) reading books or articles outside the textbook.

Lectures in Inclusive Classes

Deaf students who take a lecture on inclusive education need to have high grit. Grit is positive non-cognitive psychology based on individual enthusiasm for long-term goals, coupled with strong motivation to achieve their goals. Duckworth (2016) and Reed & Jeremiah (2017) wrote that grit is a toughness in trying to overcome obstacles or challenges to achieve the desired results and function as a driving force in achieving.

According to Jin & Kim (2017) and Zhao *et al.* (2018), the characteristics of grit for deaf students are as follows. (1) Students like to try hard in doing challenging assignments. (2) Students are not afraid of failure. (3) grit students survive when they experience difficulties in the process. (4) Students maintain their interests and efforts to complete the task. (5) Students have the perseverance to achieve their success. Demidova (2016) wrote that in the world of programming, many program languages and program applications are contained in it. Deaf students need to have a strong spirit and fighting power. For this reason, the lecturers' effort to develop the interactive multi-function videos prototype made, which can be applied inclusively in

a lecture is very necessary.

Development of Assistive Technology Produced

The development of assistive technology produced is as follows: (1) Identified the main courses in the department of computer science which for deaf students is relatively difficult to understand; (2) Courses that are difficult to understand by deaf students are then made into teaching materials in the form of video because lectures at UNNES are conducted online; (3) Videos that have been made are then combined with a video of a translator who translated the lecturer's explanation with sign language; (4) Thus, assistive technology for deaf students in the Department of Computer Science FMIPA UNNES through the interactive multi-function videos prototypes made can be applied inclusively in a lecture. At the prototype stage, 4 x 14 interactive multi-function videos have been made for courses: (1) Programming Algorithms and Data Structures, (2) Discrete Mathematics, (3) Introduction to Information Technology, and (4) Basic Statistics; (5) For the combination of 2 videos to be good and have the feasibility to be used as an assistive technology learning media, then the finishing of video making is submitted to the expert; (6) Example Figure 1, Sketch for Basic Statistics course is as follows *(see figure 1).*
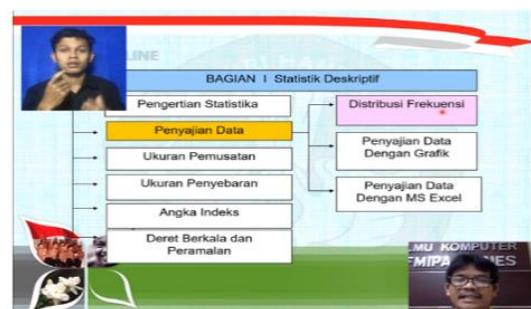
Figure 1: Basic Statistics Sketch

(7) Regular students attend online lectures through the video explanation from the lecturer. Deaf students can attend online lectures through video explanations from lecturers accompanied by sign language; (8) This video can be uploaded to *YouTube*, the URL address is linked to ELENA, and deaf/regular students can communicate with the lecturer **interactively** through the forum menu on ELENA. Elena is an LMS provided by UNNES for online lectures during the Covid-19 pandemic period.

METHODS

The method used is Mixed Methods, namely the R & D (Research and Development) approach with 9 stages of action and with a qualitative approach. The qualitative approach refers to Miles & Hubberman (2014) and Creswell (2018) who explained that data analysis activities include: (1) data reduction, (2) data display, (3) data interpretation, and (4) conclusion/verification.

The R & D approach based on Borg & Gall (2003) and Earle & Easton (2013) is carried out with **9 stages** as follows. **Research Stages** consist of: (1) Identified main courses in the Department of Computer Science which are relatively difficult to understand by deaf students; (2) Courses that are difficult to understand by deaf students are then made into teaching materials in the form of videos because lectures at UNNES are conducted online; (3) Videos that have been made were then combined with a video of a SIBI translator who translated the lecturer's explanation with sign language; (4) Thus, assistive technology for deaf students in the Department of Computer Science FMIPA Unnes through the interactive multi-function videos prototypes made can be applied inclusively in a lecture; (5) For the combination of 2 videos

to be good and have the feasibility to be used as an assistive technology learning media, then the finishing of video making is submitted to the expert and used as a blueprint prototype; (6) Prototypes and 2 x 14 interactive multi-function videos have been made for courses: *(a) Programming algorithms and data structures. (b) Discrete mathematics, which is tested*; (7) Focus Group Discussion was conducted to analyze the results of trials and revise the prototype of interactive multi-function videos as needed. **Development Stages**, consist of: (8) At the development stage, it is done by producing the results of the revision of the interactive multi-function videos prototype by involving the courses, namely: *(a) Programming Algorithms and Data Structure, (b) Discrete Mathematics, (c) Statistics, and (d) Introduction to Technology Information, which has been tested for trials*; and (9) Assistive technology products have been made for use in online lectures through inclusive education for deaf students and regular students.

Success Indicators

Success indicators are as follows: (1) There are the products in the form of Assistive Technology Prototypes for deaf students at the Department of Computer Science, FMIPA UNNES in the form of interactive multi-function videos lectures at the Information Systems Study Program, including courses *(a) Programming Algorithms and Data Structures, (b) Discrete Mathematics, (c) Statistics, and (d) Introduction to Information Technology*; (2) Assistive Technology Prototypes for deaf students in the Department of Computer Science, FMIPA UNNES through the resulting interactive multi-function videos, can be applied **inclusively** in online lectures that can be linked with ELENA; and (3) The results of a sci-

entific study showed that the absorption of deaf students in the Department of Computer Science, FMIPA UNNES, after using the Assistive Technology prototype in the form of interactive multi-function videos, resulted at least in category B, which a final score of least got 71.

RESULTS AND DISCUSSION

Assistive Technology Videos for Deaf Students

Through this research, the products have been produced in the form of a Multi-Function Assistive Technology video prototype for deaf students in the inclusive class of the Information Systems Study Program, Department of Computer Science, FMIPA UNNES. 4 courses have started having this Multi-Function Assistive Technology video, namely: (1) Programming Algorithms and Data Structures, (2) Discrete Mathematics, and (3) Introduction to Information Technology, and (4) Statistics. Each course has a minimum of 10 videos.

Each Multi-Function Assistive Technology video is developed with the following steps.

The PPt that has been made must be converted into a video format *(see Figure 2).*
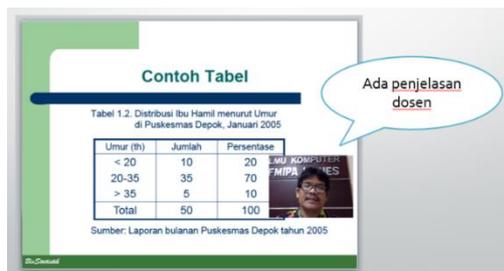
Figure 2: PPt of Basic Statistics

Next, a sign language translator video is made, in Figure 3 whose gesture must match the lecturer's voice narration.

Figure 3: Sign Language

A video that has been made with the lecturer's narration voice, is then combined with a video of a translator who translated the lecturer's explanation into Sign Language *(see Figure 4).*
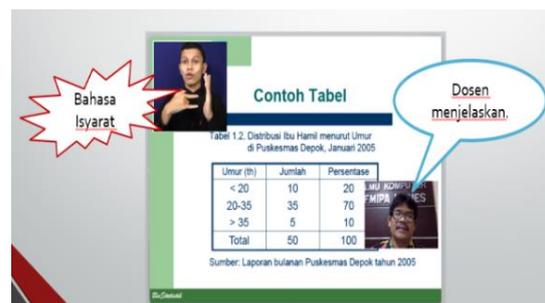
Figure 4: Combined Voice and Sign Language

A video that has been made with the lecturer's narration voice, which has been combined with a video of a translator translating the lecturer's explanation in Sign Language, then recorded/saved with MPEG-4 Video extension so that it can be uploaded to *YouTube*.

YouTube URL address is then distributed to students, uploaded to ELENA, and can be used by lecturers as a medium for online lectures. This final video is referred to as Assistive Technology Video Prototype.

Multi-Function Assistive Technology Video Linked with ELENA

Each Assistive Technology video contains: (1) Lecture material per study topic, which is following the Semester Lecture Plan (RPS), (2) stated in the form of PPt which is converted into video format, (3) there is a voice narration from the lecturer concerned according to the content

of the material which is in PPt, and (4) there is a narration in Sign Language that is following the narration of the lecturer's explanation which is then recorded in a Mpeg-video extension so that it can be uploaded to *YouTube*.

Uploading on Youtube is intended to make it easy for all students to download it and the URL address on *YouTube* is also easy to be linked with ELENA. ELENA is a *Moodle*-based LMS created by the UNNES IT team to be used by all UNNES lecturers and students. With ELENA, students can carry out discussions, tests, open teaching materials written by lecturers, and so on interactively.

Increased Absorption of Deaf Students

To see the effectiveness of using the Multi-Function Assistive Technology video prototype for deaf students in the Inclusive class of Information Systems Study Program, Department of Computer Science, FMIPA UNNES, the team implementing this activity conducted a series of observations, interviews, and assessments, the results of which showed the facts that: (1) all students in the inclusive class in the Information Systems Study Program could accept the presence of this Assistive Technology video with pleasure and comfort, (2) there was an increase in student's activeness, and (3) there was an increase in student's absorption related to the material presented by the lecturer.

Discussions

In contrast to previous studies which both discussed education in Inclusive Classes at Universities, many previous studies discussed the need for universities to accept and provide services to students with disabilities, due to the regulations governing it, Andayani (2018).

Research by Muhibbin (2021) also explored the need for universities to accept new students with disabilities but has not studied how they study. Research by Is-rowiyanti (2013) emphasized the need for a library that is suitable for reading for students with disabilities. Meanwhile, the results of this research are clear and operational about how a study program provided a way of lectures in the Inclusive Class that consists of a combination of regular students and deaf students. Therefore, it is necessary to use Multi-Function Assistive Technology in these inclusive lectures.

The idea of making a Multi-Function Assistive Technology video prototype for deaf students in the Inclusive class of the Information Systems Study Program, Department of Computer Science, FMIPA UNNES, is a new finding because, in previous studies, no one has discussed the use of Multi-Function Assistive Technology videos for deaf students in the inclusive class, for example, the results of research by Sastradiharja *et al.* (2020) and Maghfiroh (2018).

The procurement of Multi-Function Assistive Technology videos for deaf students in Inclusive classes is not easy to implement. The obstacles include: (1) The lecturers feel that they do not have sufficient experience to give lectures to students with disabilities, especially deaf students. (2) Lecturers feel they cannot use Sign Language. (3) Giving lectures in the inclusive class is an initial experience for lecturers and students in the FMIPA UNNES environment.

However, all obstacles must be overcome. Finally, a Multi-Function Assistive Technology video prototype for deaf students in the inclusive class of the Information Systems Study Program, Department of Computer Science, FMIPA UNNES can be realized.

The most difficult stage is finding

someone who is an expert in Sign Language to use in the mathematical course material. In general, Sign Language users only used it for everyday conversation. Not in the context of scientific language and terms commonly used as a scientific language in higher education. However, with great effort and will, the researchers finally managed to get an adequate Sign Language translator.

A series of the production of Multi-Function Assistive Technology video prototypes for deaf students in the inclusive class of the Information Systems Study Program, Department of Computer Science, FMIPA UNNES, which have been carried out are as follows: (1) Identified main courses in the Information Systems Study Program which is relatively difficult to understand by deaf students; (2) Courses that are relatively difficult to understand by deaf students are then made into teaching materials in the form of PPt; (3) PPt made by the lecturer is then converted into a video that includes the lecturer's narration voice when explaining the material, this video can be used for regular lectures at UNNES which are conducted online; (4) Another video was made that specifically contains the translation of the lecturer's explanation into Sign Language; (5) The video that includes the lecturer's narration voice when explaining the material, is then combined with a video from a BISINDO translator who translates the lecturer's explanation into Sign Language; (6) Thus, Assistive Technology for deaf students in the Department of Computer Science, FMIPA UNNES through Sign Language Assistive Technology prototype that was made, can be applied inclusively in a lecture; (7) For the combination of 2 videos to be good and have the feasibility to be used as an assistive technology learning media, then the finishing of video making is submitted to the expert, as a blueprint prototype.

The Sign Language Assistive Technology video prototype that has been made includes 4 courses, namely: (1) Programming Algorithms and Data Structures, (2) Discrete Mathematics, (3) Introduction to Information Technology, and (4) Statistics. Furthermore, it has been examined in lectures in inclusive classes. The contents of the lecture material can also be connected to real life. Freudenthal (1981) wrote that teaching materials are very important to be associated with everyday life.

Focus Group Discussion was conducted to analyze the trial test results and revise the Sign Language Assistive Technology prototype as needed. It is a series of actions in R & D.

Similar research that utilizes Assistive Technology in the form of teaching aids or the availability of lecture facilities for inclusive classes, for example, the research by Utomo & Suranto (2019), Istiqomah (2020), and Jannah *et al.* (2021). However, the results of this research are expected to be **new findings** that can be applied and developed by other universities that hold inclusive classes with deaf students. The findings are different from other researchers.

Thus, the process of making Assistive Technology products has been completed and is ready to be used in online lectures through Inclusive Education for deaf students and regular students in the Information Systems Study Program, Department of Computer Science, FMIPA UNNES.

CONCLUSIONS

The conclusions of this research are as follows: (1) There is a product in the form of a Multi-Function Assistive Technology video prototype for 4 courses for deaf students in the inclusive class of Infor-

mation Systems Study Program, Department of Computer Science, FMIPA UNNES (2) Multi-Function Assistive Technology video prototype for deaf students in the inclusive class of Information Systems Study Program, Department of Computer Science, FMIPA UNNES, can be linked with ELENA through online lectures; and (3) Activities and Absorption of deaf students and other students in the inclusive class are getting better and better.

Suggestions that can be recommended are as follows: (1) It is necessary to develop the Multi-Function Assistive Technology videos for other courses so that deaf students in the inclusive class of the Information Systems Study Program, Department of Computer Science, FMIPA UNNES feel happier and more comfortable; (2) The existence and availability of Multi-Function Assistive Technology videos for deaf students in the inclusive class of Information Systems Study Program, Department of Computer Science, Faculty of Mathematics and Natural Sciences, UNNES can be socialized and published in a wider area, nationally, especially in universities that have faculties in the field of education.

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