

An extended essay in computer science and economics about the societal implications of implementing AI technologies for educational purposes.

To what extent does the increasing implementation of AI technologies for IB students and teachers in a large international school create societal issues?

World Studies: Computer Science and Economics
Science, Technology and Society

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Introduction.....	2
Research Methodology.....	2
Building AI Chatbot.....	3
Primary Data Collection.....	10
Student Survey.....	10
Teacher Interviews.....	10
Analysis of Societal and Economic Issues.....	11
1. Impact of AI on Teaching and Teachers.....	11
2. Impact on Students Learning.....	13
3. AI Bias.....	14
4. Economics Effects.....	16
5. Changing Labour Landscape.....	17
Conclusion.....	19
Bibliography.....	20
Appendix.....	23
Source Code.....	23
Survey/Interview Transcripts.....	30

Introduction

“The study (of artificial intelligence) is to proceed based on the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it,” (Singh & Hiran 2022). Although initially focused on being implemented in technology industries, the scope of artificial intelligence has expanded where 35% of companies are currently employing AI technologies. Additionally, already a large number of students use generative AI tools such as ChatGPT to assist with their learning. There are a range of views on whether or not this is valuable to students' education. We can look to examine these effects through the views of 2 different key stakeholders in the education sector: students and teachers. The essay will focus on evaluating whether or not societal issues will arise with the increased integration of AI in education, to inform schools whether or not they should take this action. To narrow the scope of the research, I intend to focus on looking at the effects on IB students and teachers in a large international school. Accordingly, the research question I will be aiming to answer is: **To what extent does the increasing implementation of AI technologies for IB students and teachers in a large international school create societal issues?**

Research Methodology

As this is a world studies extended-essay, I will focus on the context of IB students and teachers in an international school. To reach a justified statement by achieving a thorough understanding of this topic, I will conduct research through academic journals, a survey for IB students, and interviews with teachers. The essay will focus on analysing the 5 biggest concerns aligned with increased AI implementation in education, and analyse the likelihood of these issues within a large international school.

These include

1. Impact of AI on Teaching and Teachers
2. Impact on Students' Learning and Development

3. AI-Bias
4. Economic Effects
5. Changing labour landscape

This will act as a guide to maintain a standpoint from both my chosen subjects, Computer Science and Economics. The influence on the above societal issues will be analysed with a mix of primary data collected from the surveys and interviews, and secondary data. A multidisciplinary essay is useful as it provides a comprehensive analysis of AI in technology and economic perspectives, creating a holistic review of the possible effects of AI in education.

Building AI Chatbot

Because the essay focuses specifically on IB students and teachers, I wanted to analyse the use of AI technologies in the classroom first-hand. This was confirmed by building an AI education study-buddy prototype (AI-ESB), which is specifically designed to help IB students. An AI-ESB is defined as “Chatbot or voice assistant that can answer students' questions about specific subjects, provide study tips and resources, and quiz them on key concepts.” (OpenAI, 2023).

The AI-ESB was built using Python, and TensorFlow (open-source library), which is popularly used when looking at machine learning and AI programming and the project extensively utilises Natural Language Processing (NLP) techniques which is a branch of machine learning focusing on the ability of computers to understand text similarly in the way humans can. (IBM, n.d.). This enables the chatbot to be able to effectively understand and communicate with students.

The chatbot works by using training data to understand what is happening and formulate patterns. It then uses these patterns to predict what the result will be and guess the action it should take, as described in Figure 1 (MIT Sloan, 2021).

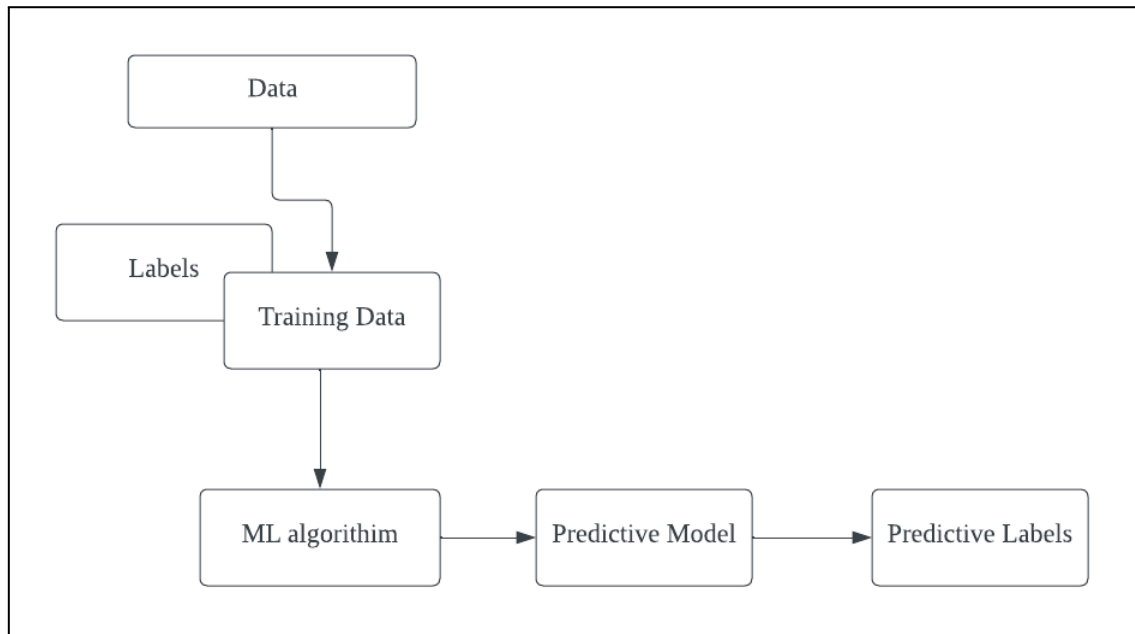


Figure 1: Simple Machine Learning Development Process (author's own)

This is implemented by building a simple neural network. Neural Networks are a class of ML algorithms that follow a supervised learning model (Adams, 2019). Supervised learning means that each labelled training data has a labelled desired output. (MIT Sloan, 2021).

Building the chatbot can be broken down into two stages:

1) Building the model, and 2) Implementing the model.

Step 1a: Providing context to the chatbot with training data

In building the AI-ESB, I use training data to create a machine learning model to be able to predict the chatbot's responses from the given intents. The training data I provided was specifically academic and IB-related data which could be used effectively by the students (*See Appendix, Intents.json*).

Step 1b: Preprocessing training data

These few algorithms are critical for the chatbot's algorithm, as they help to improve the accuracy of the responses. This involves stemming, and lemmatizing the phrases inputted, and taking out characters which should be ignored by the chatbot.

```
stemmer = WordNetLemmatizer() #creates a word stemmer
#making sure the AI can recognise the word is easier at its simplest form

#looping through the intents file
for intent in intents['intents']:
    for pattern in intent['patterns']:
        words = nltk.word_tokenize(pattern)
        wordList.extend(words)
        documents.append((words, intent['tags']))
        if intent['tags'] not in tags:
            tags.append(intent['tags'])

wordList = [stemmer.lemmatize(word) for word in wordList if word not in ignore]

wordList = sorted(set(wordList)) #sorts + lemmatizes
tags = sorted(tags)
#create pickle files containing all words +classes
pickle.dump(wordList,open('words.pkl','wb'))
pickle.dump(tags,open('tags.pkl','wb'))
```

Figure 2: Process of Tokenizing and Lemmatizing all the words from the training data.

Stemming involves removing common word endings to reach the root, e.g “running” becomes “run”. While lemmatizing reduces a word to its base form, e.g “flew” becomes “fly”. By the end of the preprocessing stage, each phrase is broken down into its meaningful parts.

Step 1c: NLP Technique of BoW

We now use a method called creating a Bag-Of-Words (BoW). This is a common NLP technique used to be able to create a neural network model. It is the simplest method to represent the input phrase in a numerical way. This works by assigning each meaningful part in the BoW either 0, or 1, depending on whether or not it is recognised in the user's input phrase. This is repeated for all training data to create the model and create a list that includes the BoW for each possible pattern given in the training data.

```

#training: need numerical values to feed into the neural network
#set individual word values to 0, 1 depending if its occuring in the pattern
trainingList = []
outputEmpty = [0]*len(tags) #as many 0s as classes

for document in documents: #for each combination create empty BOW
    bow = []
    word_patterns = document[0]
    word_patterns = [stemmer.lemmatize(word.lower()) for word in word_patterns]
    #for each word we want to know if it occurs in the patterns
    for word in wordList:
        #appending 1 to bag if word occurs in word patterns
        bow.append(1) if word in word_patterns else bow.append(0)
        outputRow = list(outputEmpty)
        outputRow[tags.index(document[1])] = 1 #set to 1
        trainingList.append([bow, outputRow])

```

Figure 3: Create BoW using all the training data.

Step 1d: Build the neural network chatbot model

```

model = Sequential()
model.add(Dense(128, input_shape=(len(x_train[0]),), activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(len(y_train[0]), activation='softmax'))
#softmax allows to add up results, add up percentages to near 1

# Create model - 3 layers. First layer 128 neurons,
# second layer 64 neurons and 3rd output layer contains number of neurons
# equal to number of intents to predict output intent with softmax
#Stochastic Gradient Descent (SGD) optimizer class from TensorFlow's Keras API.
sgd = SGD(learning_rate=0.01, momentum=0.9, nesterov=True)
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])
mod = model.fit(np.array(x_train), np.array(y_train), epochs = 200, batch_size = 5, verbose = 1)
#feed same data 200 times into neural network, in batches of 5
model.save('chatbot_model.h5', mod)
print("model created!")

```

Figure 4: Building the chatbot model

Now that we have the training data preprocessed and in numerical form, we use it to build the model to train the chatbot. We use a Stochastic Gradient Descent model (SGD) to train the ChatBot ML algorithm. SGD models are an iterative optimization process which is optimized for accuracy

and is used to find the minimum of a cost function which acts as a barometer. (Shalev-Shwartz & Ben-David, 2014). The model continuously alters the input parameters to attempt to minimise the error. An SGD function evaluates each training example one at a time. It then runs a training epoch (pass of the training dataset through the model) for each example within the dataset.

Step 2a: Preprocessing and creating BoW for users' input data

Similarly to when we built the model, we need to process the user's input phrase to its simplest form and create the BoW.

```
#function for cleaning up the sentence
def clean(sentence):
    sentence_words = nltk.word_tokenize(sentence)
    sentence_words = [stemmer.lemmatize(w) for w in sentence_words]
    return sentence_words

#bag of words function: converting sentence --> bow
def createBOW(sentence):
    sentence_words = clean(sentence)
    bow = [0]*len(words) #for as many words
    for w in sentence_words:
        for i, word in enumerate(words):
            if word == w:
                bow[i]=1
    return np.array(bow)
```

Figure 5: Cleaning up users' input phrase (lemmatize + create BoW)

Step 2b: Predicting response using chatbot model

In predicting, the BoW goes through the neural network which may look as follows:

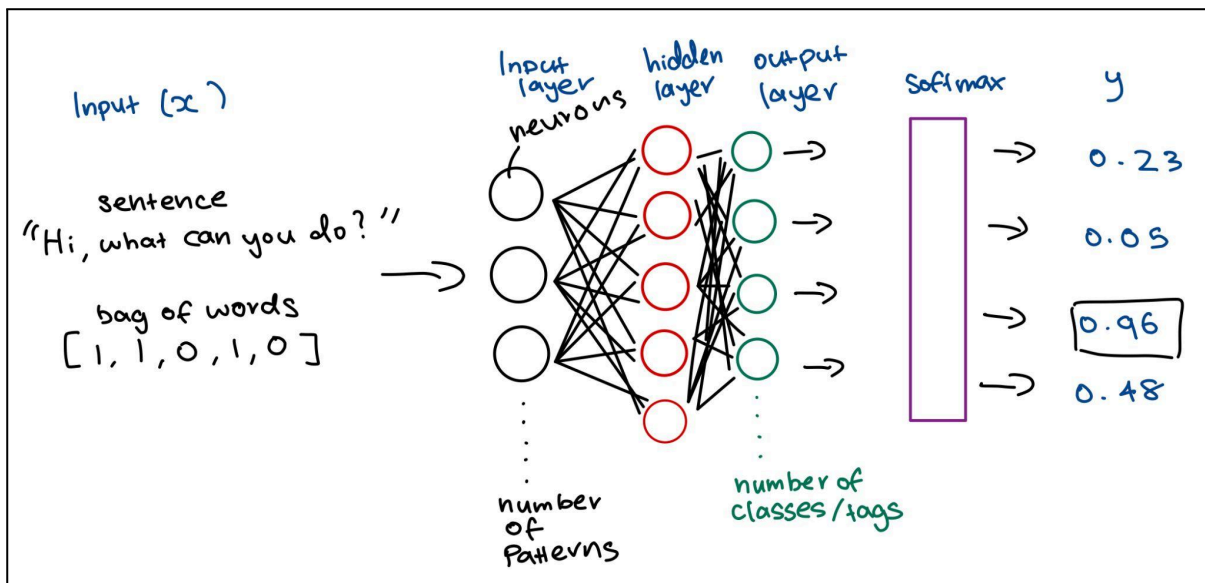


Figure 6: Chatbot Neural Network Process (author's own).

The labelled data moves through nodes, and different nodes assess the information and then arrive at an output that the model prescribes. (MIT Sloan, 2021). In a neural network, each input is given different weights and biases (strength of synaptic connection), given into an input layer. This net input is then given to the threshold function, which generates outputs that are predicted class labels for the user input. The model uses all the possibilities in the BoW and an activation function (softmax) to give each tag a probability up to 1, of how likely the response is from the tag/class. The AI-ESB will take the response from the tag which has the probability closest to 1, and return this response to the user.

```
def predict(sentence):
    bag = createBOW(sentence)
    result = model.predict(np.array([bag]))[0]
    ERROR_THRESHOLD = 0.25
    res = [[i,r] for i, r in enumerate(result) if r > ERROR_THRESHOLD]
    #predict result, enumerate results to get class, and probability,
    # sort by probability in reverse order
    res.sort(key=lambda x: x[1], reverse = True)
    returnList = []
    for r in res:
        returnList.append({'intent': tags[r[0]], 'probability': str(r[1])})
    return returnList #return the list of responses that of highest probability
```

Figure 7: Using a model to get a probability for each tag above an error threshold.

As shown in *Figure 8*, the AI-ESB takes the user response and returns what it thinks is the most accurate response based on the prediction from the neural network. The AI-ESB is immediately able to recognise inputs such as greetings and explain the AI-ESB's function. It is also able to recognise more complicated tags and give responses that give study tips to students. Making it successful in providing IB students with a focused learning tool to assist them with learning questions.

```

IB EduBot is running____
You: hi
1/1 [=====] - 0s 115ms/step
EduBot: Hi there! How can I help?
You: what can you do?
1/1 [=====] - 0s 27ms/step
EduBot: I'm an intelligent chatbot here to assist you with your learning in any field,I can provide learning resources, study tips, answer subject-specific questions, and offer general educational support. How can I assist you today?
You: help give me some study tips please
1/1 [=====] - 0s 25ms/step
EduBot: Here are some study tips that can help:
1. Create a study schedule and stick to it.
2. Break your study sessions into smaller, manageable chunks.
3. Take regular breaks to recharge and avoid burnout.
4. Use active learning techniques like summarizing, teaching others, and solving practice problems.
5. Stay organized and review your notes regularly.
Remember, finding the study methods that suit your learning style is key.
You: can you explain what knowledge questions are, im confused
1/1 [=====] - 0s 26ms/step
EduBot: Knowledge questions are fundamental to TOK. They are open-ended questions that inquire about the nature, scope, and validity of knowledge in a particular area of knowledge or across multiple areas. Knowledge questions go beyond factual information and challenge assumptions, biases, and different perspectives. They explore the complexities and uncertainties of knowledge, promoting critical thinking and reflection. Knowledge questions are at the heart of TOK as they guide inquiry, investigation, and the construction of knowledge.
You: thank you! bye!
1/1 [=====] - 0s 24ms/step
EduBot: You're welcome!

```

Figure 8: Conversation between the user and AI-ESB

The AI-ESB focuses on giving quick and precise responses to students which answers their questions in a simplistic format. This model provides students with cursory answers which can act as a platform for students to build their knowledge upon ensuring students are not reliant on the AI-ESB to tackle school problems. Instead, they can use it as a tool which assists their learning and educational journey.

Primary Data Collection

Student Survey

As the AI-ESB is a prototype for implementing AI technologies in a large international school, we need to evaluate the success of implementing the chatbot. Therefore, a survey was created for 25 IB students, to gain feedback on the effectiveness of the chatbot after testing it for 10 minutes to collect quantitative and qualitative data regarding how AI would be used by students to complement their learning strategies (*See Appendix*). This survey was anonymously conducted to encourage honest responses.

The mean overall experience students rated after they used the chatbot was 3.84/5, demonstrating how students were relatively satisfied with the product after 10 minutes.

Additionally, 17/25 students responded that they found the chatbot gave helpful responses:

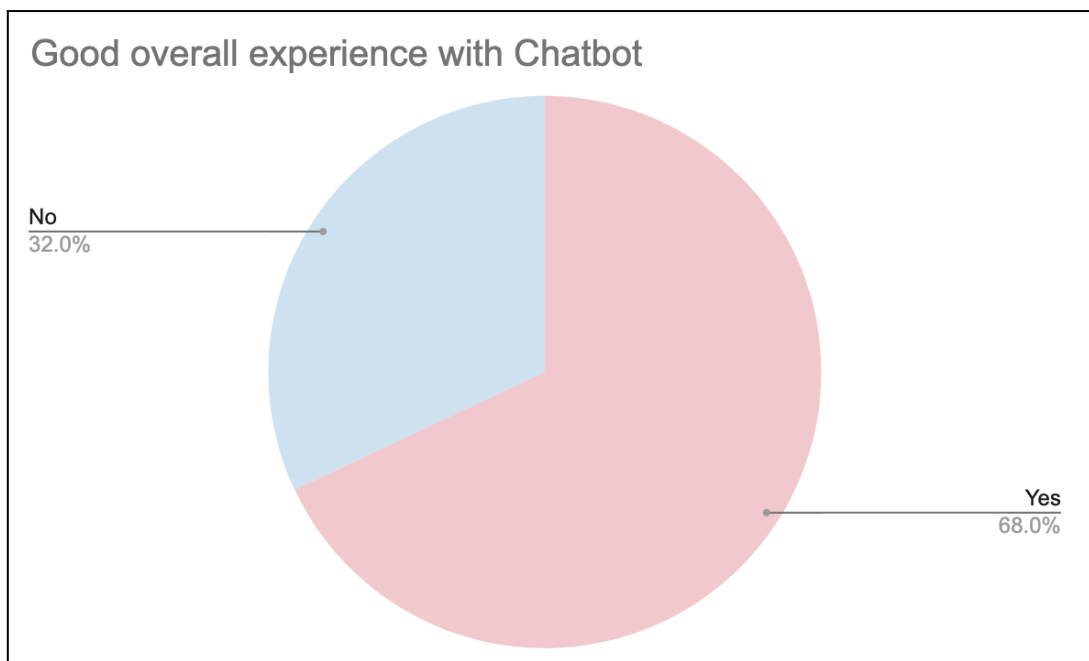


Figure 9: ChatBot provides Helpful Responses Pie Chart

The benefits and concerns that the students believed to be associated with the use of the chatbot were listed and it was found that many students thought the Chatbot was beneficial in answering IB-specific questions for a range of subjects. However, the majority of the responses highlight they have concerns with data privacy when using the chatbot.

In addition to analysing users' experience with the Chatbot, the survey also took into account students' current use of AI tools.

Teacher Interviews

Besides the survey, two teacher interviews were conducted with an IB Economics teacher and an IB Chemistry teacher (*See Appendix, Interview transcripts*) in order to gain a personal insight into teachers' views on the advantages and disadvantages of current AI use within their classroom, and opinions on the increased integration. This is critical as teachers are pedagogical stakeholders within schools.

Analysis of Societal and Economic Issues

To analyse the extent to which the increased implementation of AI technologies in a large IB international school creates societal issues, we need to understand the possible societal issues that may arise.

1. Impact of AI on Teaching and Teachers

Although it is naturally assumed students use AI education tools most frequently, teachers will have to adapt to the changing environment in the classroom with the increase of these technologies. Teachers most commonly use AI tools to recognise students' strengths and weaknesses easily from the use of AI adaptive learning features. Data analysis tools in adaptive learning systems such as Khan Academy are commonly used for this purpose, compiling this data can generate the most

effective teaching strategies for students of different abilities. Teachers can use this data to support students in being able to focus on their weaknesses as they can be more clearly identified. (Singh & Hiran 2022).

However, a large concern is that the use of AI in classrooms may extend out of the teacher's reach. This describes the movement towards dehumanised learning, where if teachers do not effectively use AI tools and begin to heavily rely on them, students may follow by example and put more weight on how much they rely on AI tools instead of focusing on human interaction in the classroom. Eventually, this disconnection in the classroom may lead to a decrease in human engagement and excitement within the class. Therefore teachers need to understand the needed balance between the use of AI, and the need for collaboration and personalised connections with their students. AI can take over trivial tasks such as grading assessments and creating lesson plans (Holmes et al., 2023) saving teachers time and allowing them to improve their relationships with students.

Although secondary sources have brought attention to the risk of AI creating a dehumanizing environment within the classroom, an interview conducted with an IB economics teacher in a large international school showcases a different view. The teacher mentions that he “noticed an improvement in student engagement and participation as the chatbot helps them apply economic principles to current events and scenarios,” describing how the implementation in this particular subject does not create a large negative impact on teachers and teaching.

Additionally, as seen in the survey data collected by students who used the AI-ESB, the chatbot still requires “enhanced subject support,” therefore the role of teachers is not completely unserviceable. This is again emphasised through both teacher interviews (*See Appendix*) showing how there are worries that the information in the chatbot is not “up-to-date” outlining why a balance between AI

and human interaction in the classroom is pivotal. This is because AI cannot foster emotional intelligence, social skills and personalised learning experiences the same way teachers can

To avoid teachers being substituted by AI tools, schools should aim to provide training and support to teachers so that they can embrace AI as an enhancement rather than a replacement.

Therefore, although to some extent there are negative effects on teachers and teaching through implementing AI tools in education, the positive effects outweigh the negatives, as shown through the teacher's perspectives, and the continuous strong student engagement in the classroom demonstrates the good balance between AI learning and teaching in this context.

2. Impact on Students Learning

The integration of AI in education requires schools to foster the growth of skills aligned with the needs of technologically advanced economies (Chan, 2023). Advancing digital literacy skills as it prepares them for the digitally reliant workforce they will be entering. Therefore, schools must invest a large amount of resources into producing curriculums which involve learning these skills but also retain students practising critical thinking skills to be able to work in future forward-thinking jobs.

Schools which integrate more AI technologies within their systems allow students the opportunity of navigating through uncertainties surrounding AI technologies. This can develop problem-solving and improve resilience skills which will benefit the students in possible future jobs in automated societies. Hence by integrating AI in education systems, skill gaps can be reduced which will improve students' employability and will contribute to economic sustainability.

Furthermore, in large international schools, a common disadvantage for students is tackling language barriers. AI can help to increase students' motivation for learning by assisting with translating and helping international students grasp a new language in a personalised manner. This in turn helps to improve the inequality gap of who can use AI tools effectively. (Wang et al., 2023).

Based on the results of the survey for IB students in a large international school (*See Appendix*), it was found on a scale from 1 to 5, representing how often students use AI-powered tools for their learning, the average rating was 2.96. This describes how the majority of students use AI for their learning occasionally. Furthermore, on a scale from 1 to 5, the survey group averaged around 2.46 which described how students would not be affected negatively to a large extent if they were to lose access to AI-powered tools. These survey results describe how although students have become accustomed to using AI-powered tools for their education regularly, they feel they are not quite dependent on AI tools and would be able to continue the same level of learning without AI tools available.

A successful AI education tool can be measured by efficiency and effectiveness. The measure of efficiency focuses on not only how quickly the AI tool works to respond to students, but also focuses on the extent to which students can grasp and fully understand new things and share what they have learned. On the other hand, the measure of effectiveness is how well the students can show what they have learned. (Singh & Hiran 2022).

Moreover, the survey highlights the biggest proponent for students, who used the AI-ESB, is the adaptability and efficiency functions of AI tools. (Singh & Hiran 2022). Because of this students adjust the prompts, and they may give AI education assistance tools to easily give them detailed answers/instructions based on their school work. This takes out a main factor of the learning process which focuses on critical thinking and creativity from students, as they are purely relying on AI

tools to complete tasks for them. Because of this, it may lead to lower education standards in students (Holmes et al., 2023). The AI-ESB is a model example of avoiding this. For instance, as it focuses on solely providing short definitions to students, it still requires the use of critical thinking skills when completing school assignments. This demonstrates how the AI-ESB is both efficient and effective for students, alleviating the negative impact on students' learning.

3. AI Bias

Among the earliest discussions which were brought up regarding the use of AI in education, were the ethical impacts of AI. Based on a study, "Use of generative AI tools have been used by at least one-third of college students surveyed in the US." (Chan, 2021). The understanding of technology is unknown to many, in comparison to the number of people using AI tools to assist them in their learning. Because of these concerns, researchers have agreed on criteria which when matched create grounds for a trustworthy AI tool. The following criteria are adapted from Dignum, and Chan from their respective studies both conducted in 2021:

a) Transparency, all decisions made about the algorithm can be simply expressed to others.

Additionally, the AI system is auditable meaning external individuals who are not developers of the system can have access to the AI algorithm. This is because there are large privacy concerns here because there is no clear understanding of who owns the data that the system collates. (Holmes et al., 2023).

b) Inclusivity, the AI tool should be accessible to everyone, meaning it should be distributed as a free good, where individuals do not need to pay to use it.

c) Accountability, the values and decisions made by stakeholders will be included in the AI tools' functions.

d) Sustainability, the implementation of the AI tool will be long-lasting and can provide beneficial insights for the future. (Dignum, 2021).

Based on the survey results, it was found that students were most concerned about their data privacy with regard to using the chatbot. Therefore, schools should place an emphasis on following these criteria for the AI integration to be successful.

Besides this, a large upcoming concern of the implementation of tools includes human biases that may be incorporated into algorithms, through the training data. (MIT Sloan, 2021). This may be influenced by human decisions or reflected by one's social identity. (Manyika et al., 2019).

In an attempt to minimise this, when building AI tools for education, developers use a method known as “counterfactual fairness” which implies how the decisions an AI model makes would be the same in a counterfactual world where people of different demographic groups would receive the same results from the AI model. (Kusner et al., n.d.).

This can be demonstrated through the use of the AI-ESB, which does not take into account the gender, race, or any form of social identity of the user. Principally, the tool aims to assist students learning by providing general tips and broad definitions for topics they are unclear about. Therefore, we create a baseline understanding of these points without introducing any form of complex biases when creating the intents (*See Appendix, Intents.json*). The model purely focuses on tokenizing the user's input phrase into meaningful parts that it recognises through the intent data. Therefore, for different demographic groups, the AI-ESB will provide consistent responses, representing a method of reducing bias in AI.

4. Economics Effects

The overarching economic concern with AI technologies in schools is the cost of implementing these technologies. To make sure the AI is responsible by following the ethical principles above,

schools must be able to provide AI technologies for everyone no matter their background if they choose to implement it. (Chan, 2021). The barrier appears as the cost of purchasing the expensive hardware and developing the software to produce an effective AI-powered tool for one classroom. This is impractical for schools because many education systems suffer from underfunding and overworked staff, therefore it would not be economically efficient to proceed in this manner. (Rafferty, 2023).

Another factor is the need for schools to provide training for teachers to improve their digital literacy, which can result in being quite time-consuming and costly. (Holmes et al., 2023). Furthermore, working with AI developers to be able to create personalised AI tools that will constructively work with schools' curricula may include excess expenses due to licensing existing AI software, and integrating it with the school's existing systems.

To decide whether or not the implementation of AI tools is beneficial, we need to understand the potential return on investment (ROI) for schools that effectively integrate AI. ROI is defined as “a financial ratio of an investment’s gain or loss relative to its cost.” (Rao, 2021). Using the survey and interview responses, a list of investments and returns has been outlined in the following table.

Table 1: Outline of possible investments and returns associated with increased AI implementation

Investments	Returns
<ul style="list-style-type: none"> - Cost of Hardware - Cost of personalised software development - Cost of Teacher training 	<ul style="list-style-type: none"> - Time Savings (repetitive tasks: grading) - Cost Savings - Productivity increases (<i>See Appendix, Interview 2</i>) - A better experience for students through personalised learning (<i>See Student survey data</i>) - Skill retention (for students)

Overall, the returns are greater the investments, demonstrating how the investment in AI tools for education should be economically beneficial for a variety of stakeholders.

5. Changing Labour Landscape

It has already been found that real wages have been gradually falling, although GDP is still rising. The increase of AI technologies used in society, such as in the education sector, could have provoked this. (Brynjolfsson, 2021). In the short run, it may seem more profitable for AI to take over jobs due to advantages in capital-intensive workforces such as minimising human error, and increased labour productivity, which leads to an increase in economic output and can benefit the firm by a great amount. In the long run, however, if AI tools continue to take over jobs in education, this will create greater technological unemployment. This can be represented by the following shift in the diagram, where demand for labour decreases, although the quantity of labour remains the same.

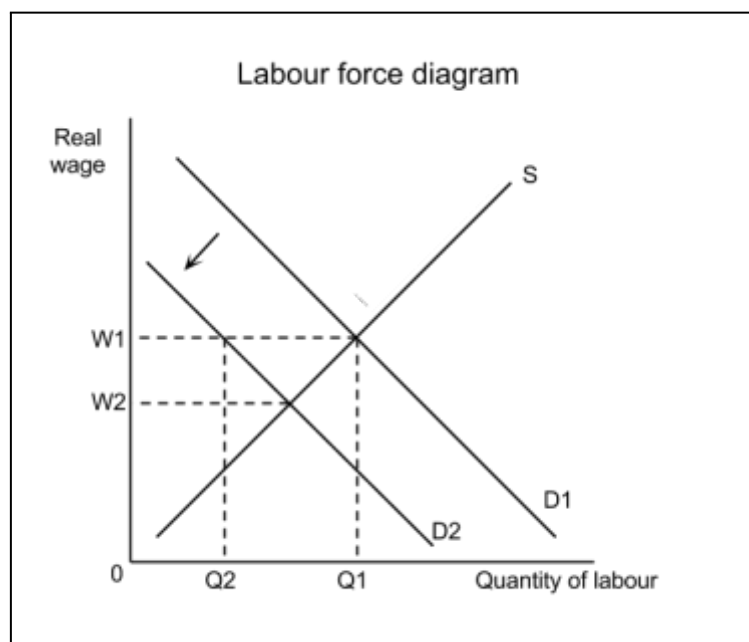


Figure 10: Leftward shift in demand for labour. (The IB Economist, n.d.)

This in turn leads to a lower standard of living for teachers, attributing to lower economic growth.

However, if properly implemented in schools, the implementation of AI can be used for repetitive mundane tasks such as creating and grading papers and creating schedules, to make sure jobs in education will not necessarily become obsolete, and instead nuanced (Melehy, 2023).

The overall changing labour landscapes describe how as society gets closer to automation, some industries may lead to jobs becoming completely obsolete due to AI; leading to lower standards of living for the general population (Melehy, 2023).

Although in this specific international school, there are not large concerns regarding the changing labour landscape, however, globally there are still large concerns. Increased technological unemployment may affect income inequality in a society. These may need to be reduced on a larger scale through the following methods:

1. Collaborative Decision-Making: Involve teachers and staff in decisions about technology adoption to ensure their concerns are addressed.
2. Fair Compensation Policies: Implement fair compensation policies that take into account changes in job roles and responsibilities due to technology adoption.
3. Efficiency and Resource Allocation: Improve administrative efficiency through automation and new technologies. This allows for resource reallocation to improve staff development

If these methods are considered, the negative effects of a changing labour landscape associated with increased AI tools within schools may be reduced.

Conclusion

Increased implementation of AI technologies in the environment of a large international school conclusively leads to multiple societal issues. These issues however are largely inconsequential within this context. Through understanding how AI tools can be created and used via the AI-ESB,

the possible societal effects AI-powered tools can bring to education sectors are more clearly presented.

It is imperative to acknowledge the limitations associated with the study. The survey conducted was specifically for one large international school, and may not represent the scope of all large international schools around the world. Furthermore, most secondary research conducted was in a general context, and not specific to the effect of AI in education.

In evaluating the possible integration, it is critical to examine the effects on the different stakeholders: a) students and the effect on their learning, b) teachers and highlighting the possible changes within the classroom, where the school needs to prioritise providing fair use of AI for all students. While there are many issues that arise from the integration of AI technologies, through responsible implementation, the effects of these issues can be mitigated. Furthermore, by planning out the possible integration in advance, educators can create a more equitable and economically sustainable AI-powered educational landscape.

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Appendix

Source Code

Intents.json file

Basic Intents were generated by ChatGPT (OpenAI, 2023)

```
"intents":[  
  
  {  
  
    "tags": ["greeting"],  
    "patterns": ["hi", "hello", "hey"],  
    "responses": ["Hello! How can I assist you?", "Hi there! How can I help?"]  
  }  
]
```



```

},
{
  "tags": ["goodbye"],
  "patterns": ["bye", "see you", "goodbye"],
  "responses": ["Goodbye! Have a great day!", "Take care. See you soon!"]
},
{
  "tags": ["thanks"],
  "patterns": ["thank you", "thanks a lot", "appreciate it"],
  "responses": ["You're welcome!", "Glad I could help.", "No problem!"]
},
{
  "tags": ["Introduction"],
  "patterns": ["what can you do", "tell me about yourself"],
  "responses": ["I'm an intelligent AI-ESB here to assist you with your learning in any field, I can provide learning resources, study tips, answer subject-specific questions, and offer general educational support. How can I assist you today?"]
},
{
  "tags": ["learning_resources"],
  "patterns": ["recommend learning resources", "where can I find learning materials"],
  "responses": ["Sure! Here are some recommended learning resources. Online learning platforms like Coursera, edX, and Khan Academy.\n2. Open educational resources such as MIT OpenCourseWare and OpenStax.\n3. YouTube channels and educational podcasts in your field of interest.\nRemember, exploring different resources and finding what works best for you is essential for effective learning."]
},
{
  "tags": ["study_tips"],
  "patterns": ["give me study tips", "how can I study effectively"],
  "responses": ["Here are some study tips that can help:\n1. Create a study schedule and stick to it.\n2. Break your study sessions into smaller, manageable chunks.\n3. Take regular breaks to recharge and avoid burnout .\n4. Use active learning techniques like summarizing, teaching others, and solving practice problems.\n5. Stay organized and review your notes regularly.\nRemember, finding the study methods that suit your learning style is key."]
},
{

```

```

"tags": ["subject_assistance"],

"patterns": ["I need help with [subject_name]", "can you assist me with [subject_name]"],

"responses": ["Of course! I'll do my best to assist you with [subject_name]. Please provide more details or specific questions you have, and I'll provide the necessary guidance and resources."],

},

{

"tags": ["general_support"],

"patterns": ["I have a question about studying", "need general educational support"],

"responses": ["Feel free to ask your question, and I'll provide you with the information and support you need. Whether it's study techniques, time management, or any educational topic, I'm here to assist you."],

},

{

"tags": ["ib_syllabus"],

"patterns": ["Tell me about the [subject_name] syllabus", "What topics are covered in the [subject_name] syllabus?"],

"responses": ["The [subject_name] syllabus includes topics such as [syllabus_topics]. It covers various aspects of the subject, providing a comprehensive understanding of [subject_name]. If you have specific questions or need assistance with a particular topic, feel free to ask!"],

},

{

"tags": ["ib_past_papers"],

"patterns": ["Where can I find IB past papers?", "Can you recommend sources for IB past papers?"],

"responses": ["You can find IB past papers on the official IB website, as well as other educational platforms such as Revision Village and Studynova. Practicing past papers is a great way to familiarize yourself with the exam format and assess your understanding of the topics."],

},

{

"tags": ["ib_exam_prep"],

"patterns": ["How can I prepare for IB exams?", "Do you have any tips for IB exam preparation?"],

"responses": ["To prepare for IB exams, try the following:\n1. Review your notes and study materials thoroughly.\n2. Create a study plan and allocate enough time for each subject.\n3. Practice past papers to become familiar with the exam format.\n4. Seek clarification on any challenging topics from your teachers or online resources.\n5. Take care of your physical and mental well-being to manage exam stress effectively."],

},

{

```

```

"tags": ["ib_cas"],

"patterns": ["What is CAS in the IB program?", "Tell me about the CAS component in IB."],

"responses": ["CAS stands for Creativity, Activity, Service. It is a requirement in the IB program that encourages students to
engage in activities outside the classroom. CAS involves undertaking creative pursuits, participating in physical activities,
and engaging in service projects to develop a well-rounded personality."],

},

{

"tags": ["unknown"],

"patterns": [],

"responses": ["I'm sorry, but I'm not sure I understand. Could you please rephrase or provide more context?"]

},

{

"tags": ["name"],

"patterns": ["what is your name", "name?", "tell me your name"],

"responses": ["my name is IB TutorBot, here to support your IB learning journey!"]

},

{

"tags": ["ib_computer_science"],

"patterns": ["Tell me about IB Computer Science", "What topics does IB Computer Science cover?", "I need help with IB
Computer Science"],

"responses": ["IB Computer Science covers topics such as programming, algorithms, data structures, computer systems,
software development methodologies, and more. It emphasizes problem-solving and computational thinking. If you have
specific questions or need assistance with a particular topic, feel free to ask!"]

},

{

"tags": ["supply_and_demand"],

"patterns": ["Explain the concept of supply and demand", "What factors influence supply and demand?", "Tell me about
equilibrium in supply and demand"],

"responses": ["Supply and demand are fundamental concepts in economics. Supply refers to the quantity of a product or
service that producers are willing to offer for sale at various prices. Demand represents the quantity of a product or service
that consumers are willing to purchase at various prices. Factors influencing supply and demand include price, consumer
preferences, production costs, market competition, and external factors. Equilibrium occurs when the quantity supplied
equals the quantity demanded, resulting in a stable market price."],

},

```

```
{
  "tags": ["knowledge_questions"],
  "patterns": ["What are knowledge questions?", "Explain the concept of knowledge questions", "Tell me about the role of knowledge questions in TOK"],
  "responses": ["Knowledge questions are fundamental to TOK. They are open-ended questions that inquire about the nature, scope, and validity of knowledge in a particular area of knowledge or across multiple areas. Knowledge questions go beyond factual information and challenge assumptions, biases, and different perspectives. They explore the complexities and uncertainties of knowledge, promoting critical thinking and reflection. Knowledge questions are at the heart of TOK as they guide inquiry, investigation, and the construction of knowledge."]
} ]]
```

botTraining.py

```
1  #libraries
2  import random #choosing the random intent responses
3  import json #to access the intents
4  import pickle #serializing
5  import numpy as np
6  import os
7  import nltk
8  #import ssl
9  #Disable SSL certificate verification, need for setting up nltk
10 #import ssl
11 #ssl._create_default_https_context = ssl._create_unverified_context
12
13 from nltk.stem import WordNetLemmatizer #reduces the word to its stem
14
15 #import from tensorflow: available ML and AI software for model training
16 from tensorflow.keras.models import Sequential
17 from tensorflow.keras.layers import Dense, Activation, Dropout
18 from tensorflow.keras.optimizers import SGD #gradient decent function
19
20 stemmer = WordNetLemmatizer() #creates a word stemmer
21 #making sure the AI can recognise the word is easier at its simplest form
22
23 intents = json.loads(open('intentsTest.json').read()) #loading and reading json file
24 #result: getting a json object of the intents file
25
26 wordList = []
27 tags = [] #tag
28 documents = []
29 ignore = ['.', ',', '!', '?', ':'] #to ignore in input phrases
30
31 #looping through the intents file
32 for intent in intents['intents']:
33     for pattern in intent['patterns']:
34         words = nltk.word_tokenize(pattern)
35         wordList.extend(words)
36         documents.append((words, intent['tags']))
37         if intent['tags'] not in tags:
38             tags.append(intent['tags'])
```

```

39
40 wordList = [stemmer.lemmatize(word) for word in wordList if word not in ignore]
41
42 wordList = sorted(set(wordList)) #sorts + lemmatizes
43 tags = sorted(tags)
44 #create pickle files containing all words +classes
45 pickle.dump(wordList,open('words.pkl','wb'))
46 pickle.dump(tags,open('tags.pkl','wb'))
47
48 #training: need numerical values to feed into the neural network
49 #set individual word values to 0, 1 depending if its occuring in the pattern
50
51 trainingList = []
52 outputEmpty = [0]*len(tags) #as many 0s as classes
53
54 for document in documents: #for each combination create empty BOW
55     bow = []
56     word_patterns = document[0]
57     word_patterns = [stemmer.lemmatize(word.lower()) for word in word_patterns]
58     #for each word we want to know if it occurs in the patterns
59     for word in wordList:
60         #appending 1 to bag if word occurs in word patterns
61         bow.append(1 if word in word_patterns else bow.append(0))
62         outputRow = list(outputEmpty)
63         outputRow[tags.index(word)]=1 #set to 1
64         trainingList.append([bow, outputRow])

```

```

66 random.shuffle(trainingList) #shuffles training list
67 x_train = [item[0] for item in trainingList] #turns x, y training data into numpy arrays
68 y_train = [item[1] for item in trainingList]
69
70 model = Sequential()
71 model.add(Dense(128, input_shape=(len(x_train[0]),), activation='relu'))
72 model.add(Dropout(0.5))
73 model.add(Dense(64, activation='relu'))
74 model.add(Dropout(0.5))
75 model.add(Dense(len(y_train[0]), activation='softmax')) #softmax allows to add up results, add up percentages to near 1
76
77 # Create model - 3 layers. First layer 128 neurons, second layer 64 neurons and 3rd output layer contains number of neurons
78 # equal to number of intents to predict output intent with softmax
79 #Stochastic Gradient Descent (SGD) optimizer class from TensorFlow's Keras API.
80 sgd = SGD(learning_rate=0.01, momentum=0.9, nesterov=True)
81 model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])
82 mod = model.fit(np.array(x_train), np.array(y_train), epochs = 200, batch_size = 5, verbose = 1)
83 #feed same data 200 times into neural network, in batches of 5
84 model.save('chatbot_model.h5', mod)
85 print("model created!")
86
87

```

```
import random
import json
import pickle
import numpy as np
import nltk
from nltk.stem import WordNetLemmatizer
from tensorflow.keras.models import load_model

stemmer = WordNetLemmatizer()

intents = json.loads(open('intentsTest.json').read())
words = pickle.load(open('words.pkl','rb'))
tags = pickle.load(open('tags.pkl','rb'))
model = load_model('chatbot_model.h5')

#function for cleaning up the sentence
def clean(sentence):
    sentence_words = nltk.word_tokenize(sentence)
    sentence_words = [stemmer.lemmatize(w) for w in sentence_words]
    return sentence_words

#bag of words function: converting sentence --> bow
def createBOW(sentence):
    sentence_words = clean(sentence)
    bow = [0]*len(words) #for as many words
    for w in sentence_words:
        for i, word in enumerate(words):
            if word == w:
                bow[i]=1
    return np.array(bow)

def predict(sentence):
    bag = createBOW(sentence)
    result = model.predict(np.array([bag]))[0]
    ERROR_THRESHOLD = 0.25
    res = [[i,r] for i, r in enumerate(result) if r > ERROR_THRESHOLD]
    #predict result, enumerate results to get class, and probability,
    # sort by probability in reverse order
    res.sort(key=lambda x: x[1], reverse = True)
    returnList = []
    for r in res:
        returnList.append({'intent': tags[r[0]], 'probability': str(r[1])})
    return returnList #return list of intents +

def getResponse(intsList, intents_json):
    tag = intsList[0]['intent']
    list_of_intents = intents_json['intents']
    for i in list_of_intents:
        if(i['tags']== tag):
            result = random.choice(i['responses'])
            break
    return result

print("__IB EduBot is running__")

while True:
    message = input("You: ")
    ints = predict(message)
    res = getResponse(ints, intents)
    print("EduBot: ", res)
```

Survey/Interview Transcripts

Survey and Interview Questions generated by ChatGPT (OpenAI, 2023).

Interview Questions:

Introduction and Background:

Can you please introduce yourself and provide some background on your role as a teacher in this international school?

AI in the Classroom:

What are your general thoughts and perceptions regarding the use of AI technologies in the classroom?

How do you believe AI can enhance or impact the teaching and learning experience for students?

From your perspective as a teacher, what potential benefits do you see in using AI, such as the chatbot, in the classroom?

Are there any concerns or challenges you foresee in integrating AI technologies like the chatbot into your teaching methods?

Have you observed any changes in student engagement or participation as a result of using the chatbot in your classroom?

How do you gauge the effectiveness of the chatbot in helping students with their queries or academic tasks?

What recommendations or suggestions do you have for improving the use of AI, particularly the chatbot, in the classroom?

How do you envision the future role of AI technologies in education within this school?

Is there anything else you'd like to share regarding your views on AI in the classroom or your experiences with the chatbot?

Interview 1: IB Chemistry Teacher

I am an IB chemistry teacher at this international school, currently teaching two higher-level classes in grades 11 and 12.

I think AI technologies have the potential to greatly enhance the teaching and learning experience for students by providing personalized support and resources.

Using AI, such as a chatbot, in the classroom can provide benefits like instant feedback, individualized assistance, and access to a wide range of educational materials.

Challenges may include ensuring the chatbot is accurate and reliable, addressing privacy concerns, and making sure students don't become overly dependent on AI for their learning.

Yes, I've noticed increased student engagement and participation, as the chatbot makes learning more interactive and accessible.

The effectiveness of the chatbot is assessed through the quality and speed of responses, as well as improvements in student performance and understanding.

To improve AI in the classroom, it's important to regularly update and refine the chatbot's knowledge base and ensure it aligns with the curriculum.

In the future, I see AI technologies playing a larger role in education at this school, providing tailored support to students and assisting teachers in their work.

I'd like to emphasize that AI is a valuable tool that, when used effectively, can significantly benefit both teachers and students in the learning process.

Interview 2: IB Economics Teacher

I am an IB economics teacher at this international school, instructing two higher-level and a standard-level classes, all in grade 12.

AI technologies have the potential to revolutionize the classroom by providing real-world economic data and simulations, making economics concepts more practical and engaging for students.

Using AI, such as a chatbot, can help in providing real-time economic data and examples, making complex economic concepts more accessible and relatable to students.

Challenges may include ensuring that the chatbot has access to up-to-date economic information and maintaining students' interest in the subject while using AI.

I have noticed an improvement in student engagement and participation as the chatbot helps them apply economic principles to current events and scenarios.

The chatbot's effectiveness is measured by its ability to provide relevant and current economic data, enhancing students' understanding of economic concepts and their ability to analyze real-world economic situations.

To enhance the use of AI, it's crucial to integrate the chatbot with reliable sources of economic data and ensure that it aligns with the IB economics curriculum.

In the future, AI technologies will likely play an even more significant role in education, providing students with real-time economic information and fostering a deeper understanding of economics.

I want to highlight the potential of AI in making economics education more dynamic and engaging, and I'm excited about the future possibilities it brings to our classrooms.

Survey Responses:

Student	Grade	Rating	Helpful Responses	Impact of AI Tools	Frequency of AI Use	Benefits of Chatbot	Concerns in Classroom	Future Expectations	What specific features do you find most useful in the AI-powered education tools you have used?						
1	11	4	Yes	4	3	Quick access to explanations, time-saving	Privacy concerns, data usage transparency	Expanded subject support	AI powered education tools like Chat GPT are very useful since they search through huge volumes of information and compile in a manner which is concise and comprehensive						
2	12	5	Yes	5	4	Improved STEM learning, quick responses	Data privacy	Enhanced humanities support	I like that you can be really specific with chat gpt and regenerate responses						
3	11	3	No	3	2	Time-saving in STEM, needs history support	Accuracy concerns	Better essay assistance	The AI being able to condense information and sort through all of the sites on google to find information specifically for my question.						
									I find that the most useful AI-powered education is the language learning tools, most noticeably the speech recognition in Google Translate. The application enhances my personal struggle in learning Chinese by thoroughly translating the an essay without any assistances. I finds this application to be a basis for me into learning a new language.						
4	12	4	Yes	4	3	Clear scientific explanations, data security	Expanding humanities support	IB Theory of Knowledge (TOK) assistance							
5	11	4	Yes	3	2	Valuable STEM support, privacy cautious	Literary analysis improvement	Comprehensive IB support	Flash card systems to help me assimilate knowledge.						
6	12	2	No	2	1	Improved history and humanities support	Data privacy concerns	Enhanced history responses	Compilation of all information in a concise paragraph						

Student	Grade	Rating	Helpful Responses	Impact of AI Tools	Frequency of AI Use	Benefits of Chatbot	Concerns in Classroom	Future Expectations	What specific features do you find most useful in the AI-powered education tools you have used?						
7	11	5	Yes	4	2	Game-changer in math and science	Data usage clarity	HL math topic support	Summarizing text, providing feedback on work that will be graded and he neural explanations to questions have been the most helpful however I wish that I would be able to upload pictures to chatgpt and use those as inputs for my questions						
8	12	2	No	2	1	Needs work in humanities, data transparency	History and humanities improvement	Precise history responses	Searching for specific facts, definitions and theories in IB terminology						
9	11	4	Yes	2	2	IB Group 4 support, data security	Data protection priority	Enhanced IB subjects	I would say I like ChatGPT and it can come up with ideas really quick.						
10	12	5	Yes	4	3	Instant science support, data security	Expanding humanities support	TOK assistance	I like the testing and flashcards function on Quizlet in particular because it's less time consuming to handwrite flashcards						
11	11	3	No	3	1	Time-saver in math, needs literary analysis support	Data privacy concerns	Improved humanities proficiency	Rephrasing						
12	12	4	Yes	2	2	Valuable study tool, data security	Extended Essays and TOK support	Enhanced support	The ability to find information from the internet from a single question						
13	11	5	Yes	2	2	Valuable addition to IB journey	Data privacy	Business management assistance	Image/art generation + brainstorming help						
14	12	2	No	2	1	Needs work in humanities, data transparency	History improvement	Precise history responses	I feel like they make learning quicker and more convenient						
15	11	4	Yes	2	1	Valuable addition to IB journey	Data security	Expanded math topics support	It comes up with ideas for you.						

Student	Grade	Rating	Helpful Responses	Impact of AI Tools	Frequency of AI Use	Benefits of Chatbot	Concerns in Classroom	Future Expectations	What specific features do you find most useful in the AI-powered education tools you have used?					
16	12	5	Yes	3	3	Instant science support, data security	Expanding humanities support	Precise TOK assistance	Chat GPT is helpful as I believe it is quite good at interpreting my broad concepts and ideas into relatively well-structured sentences					
17	11	3	No	3	2	Potential in humanities, data transparency	Literary analysis improvement	Improved humanities proficiency	already stated above.					
18	12	4	Yes	5	4	Valuable addition to IB journey	Data security	Comprehensive IB support	Providing various suggestions (grammarly) and functions to improve my learning (flashcard, test, game in Quizlet)					
19	11	5	Yes	2	2	Valuable addition to IB journey	Data protection priority	Extended Essays and TOK assistance	Personalised Learning, Data Analyses and and the ability to assess your work (checking for plagiarism, checking for and correcting grammatical and spelling errors).					
20	12	2	No	2	1	Needs work in humanities, data transparency	History improvement	Precise history responses	The compilation and rephrasing of topics from multiple sources that are put into an easy-to-understand paragraph.					
21	11	4	Yes	2	1	Valuable addition to IB journey	Data security	Expanded math topics support	Features that act as a support, like ChatGPT and Turnitin mentioned above, and things like Github Copilot's code suggestion feature (which I haven't actually used but have seen used)					
Student	Grade	Rating	Helpful Responses	Impact of AI Tools	Frequency of AI Use	Benefits of Chatbot	Concerns in Classroom	Future Expectations	What specific features do you find most useful in the AI-powered education tools you have used?					
22	12	5	Yes	3	3	Valuable addition to IB journey	Data security	Comprehensive IB support	Adapting their approach to suit a learners capabilities (quizlet) allows the learning experience to be slightly personalised. Additionally, research tools like Elicit have a huge wealth of knowledge that they comb through to produce relevant results, cutting down the time it takes to find the information on the internet. ChatGPT has similar features that make it extremely useful.					
Student	Grade	Rating	Helpful Responses	Impact of AI Tools	Frequency of AI Use	Benefits of Chatbot	Concerns in Classroom	Future Expectations	What specific features do you find most useful in the AI-powered education tools you have used?					
23	11	3	No	3	1	Potential in humanities, data transparency	Literary analysis improvement	Improved humanities proficiency	I haven't used any - however I would say AI-powered tools in the humanities would be very useful given that it can be quite a subjective area of study where additional ideas may be useful. For instance, language learning, essay grading and flash cards all sound useful - however, I'm not too impressed by the plagiarism detector simply because if a student has cited their sources appropriately and not intended to plagiarise, they shouldn't need to check it for plagiarism as it's highly unlikely to be present.					
24	12	4	Yes	5	4	Valuable addition to IB journey	Data security	Comprehensive IB support	Personalised learning and adapting question difficulty based on performance (eg Quizlet and Duolingo)					
25	11	5	Yes	2	2	Valuable addition to IB journey	Data protection priority	Extended Essays and TOK assistance						
		3.84		2.96	2.12									