Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Investigating cognitive holding power and equity in the flipped classroom

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ABSTRACT

In recent years, the flipped classroom has been proposed as an alternative paradigm of teaching, and has been demonstrated to improve the students' knowledge and skills, engagement, and self-efficacy. At the same time, as the number of students seeking higher education is growing and the needs of these students are rapidly evolving, it has become necessary to improve their cognitive holding power and enhance equity among them. The goal of this study is to investigate the impact of the flipped classroom on improving the students' cognitive holding power and enhancing equity.

For this study, the flipped classroom was implemented for teaching undergraduate university students' course "An Introduction to Instructional Technology". In the class, whiteboard and Smartboard were used to discuss and clarify ambiguous ideas related to the topic and to present the model answers for the tasks. Outside the class, video files and Google applications (Word, PPT, Drive) were used for delivering learning materials. WhatsApp was used for communication and Google form was used for designing learning activities and assessment. The results of the study indicate: (1) to some extent flipped classroom can be a solution for improving students' cognitive holding power, especially in performing learning tasks and following teacher' instructions. (2) Equity among the students can be enhanced in the flipped classroom. These findings have implications for using the flipped classroom in managing the diversity of university students through enhancing equity among them and improving their abilities.

1. Introduction

The flipped classroom is a pedagogical approach where learning activities are rearranged to be effective in providing the educators more face-to-face interactions with students and enlarge the flexibility of learning schedule to improve the learning outcomes. The student-centered learning strategy is a cornerstone of designing an effective flipped classroom (Kim et al., 2014). Emerging technologies in the flipped classroom make teaching and learning more effective, thereby improving students' learning achievement and satisfaction (Missildine et al., 2013; O'Flaherty and Phillips, 2015). This increase in learning achievements can be a result of following the teacher instruction or of executing the learning plan. The flipped classroom can also improve the students' self-efficacy and strategies for planning their study schedule. Students with a high level of self-regulated skills, including setting goals, planning, monitoring performance and self-evaluation, can achieve a better performance in the flipped classroom (Lai and Hwang, 2016).

At the same time, the flipped classroom can be an effective approach for solving the problem of individual differences among students. Out-of-class students have much knowledge and many learning resources that allow them to learn regardless of their character traits or learning styles (Rahimi et al., 2015). Moreover, the flipped classroom can support students to be responsible for their learning, and participate in designing their learning environment in a way that makes all the students feel that they have equal learning opportunities. Many prior studies refer to the positive effect of using the flipped classroom for improving learning at the university level (Baepler et al., 2014; Kong, 2014). In this regard, two useful concepts are *Cognitive Holding Power (CHP)* and *Equity*. CHP represents following teacher instructions, planning the learning, executing the plans, and monitoring the performance. Equity represents the students' perception of equal learning opportunities. As far as we are aware, there are no existing studies on the impact of flipped classroom on improving CHP or enhancing *Equity* among university students.

The concept of CHP refers to the extent to which the environment forces students into utilizing different categories of cognitive procedures in handling the tasks in which they engage (Stevenson and Evans, 1994). CHP consist of (1) *first-order cognitive holding power (FOCHP)*, which encompasses some procedures mainly used to achieve specific goals, such

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as following and relying on teacher's instructions, executing the learning plan, passively accepting the results, confirming the results from the teacher, asking for help from the teacher; and (2) *second-order cognitive holding power (SOCHP)*, which refers to the settings that pose unfamiliar goals for students, encourage them to establish an association between the given problem and previously existing knowledge, apply various strategies to solve the problem, monitor the effectiveness of the applied strategies, and check results (Xin and Zhang, 2009). It has been argued that improving CHP leads to developing thinking skills (Stevenson, 1998). However, further studies are needed to investigate whether the flipped classroom can improve CHP.

Another major parameter in assessing the efficacy of educational technologies is that of *equity*, which is defined as providing students an equal treatment, equal educational opportunity, and educational adequacy to evaluate their progress in the learning environments toward achieving their instructional goals (Fiske and Ladd, 2004, 145). Equity also refers to students' access to the instructional resources and learning processes that affect educational outcomes. It is concerned with fairness, and a just treatment of students from different academic capabilities (Willms et al., 2012). Enhancing equity should start from designing a learning environment that offers various learning opportunities, manages the choices in the learning environment, provides attractive alternatives, prevents student dropouts, and limits postponement of academic selection. Enhancing equity also requires improving the academic practices in the learning environment: for example, providing systematic help, responding to minorities within education, and strengthening the links between university and home. Finally, for enhancing equity in the learning environment, there is a need to provide learning activities that reflect the students' needs and are appropriate for them.

There are positive correlations between equity and political interests, a healthy lifestyle, participating in democratic initiatives and students' interpersonal trust. In the long run, developing equity is economically efficient because it decreases crime and other illegal activities in our societies (Schleicher, 2014, 19–25). Leaning methods and ways of delivering knowledge and skills is one of the most important factors that influence achieving equity in learning systems, and it seems that the quality of teaching and the nature of the interactions in the educational systems are the key issues for improving the quality of educational session (Hattie, 2009, 91). With the increasing number of higher education student enrolments, which in 2016 reached to more than one million students in 33 countries worldwide (Calderon, 2018, 18), rapidly changing needs of the students to keep pace with the technological advances, and spiraling cost of education, it is more crucial than ever to achieve equity. However, there are only a few experimental studies that discuss equity in educational technology, and there is little consensus on how to enhancing equity in the flipped classroom context.

2. Research background

2.1. Flipped classroom for supporting CHP and equity

Flipped classroom, also known as inverted classroom, is a blended learning approach, which is being adapted in many higher educational systems in recent years (O'Flaherty and Phillips, 2015). In a flipped classroom, the order of traditional teaching and learning processes is swapped. The students start with studying the learning resources outside the classroom: these resources can be available on many different digital learning platforms such as websites, YouTube channels, and presentation or pdf files. Next, the students conduct learning activities by interacting with other students and teachers using the learning resources inside a classroom (Mohamed and Lamia, 2018). Consequently, the teachers in a classroom are required to make a shift from teacher-centered learning to student-centered learning. In a flipped classroom, the teacher's role is to encourage students to practice active learning, to guide students to think positively and to facilitate students reaching their learning objectives (Hwang et al., 2015). Learning through the flipped classroom in higher

education is supported by the flexible learning theory, which recommends that the students should be provided with choices about when, where, and how they learn (Ryan and Tilbury, 2013).

Prior studies have shown the following impact of the flipped classroom on the First-Order Cognitive Holding Power (FOCHP):

- Following instructions – Compared to traditional classroom, students who learn through the flipped classroom follow the teacher's instructions better (Liu et al., 2019).
- Learning via demonstration: The flipped classroom has been shown to improve the surgical skills, both for novice and experienced students, by following the instructions delivered by the teacher on videos (Liu et al., 2019).
- Reliance on the teacher – Compared to a traditional classroom, the students apply the learning roles better in the flipped classroom (Liu et al., 2019).
- Executing plans – In the flipped classroom, the teacher does not convey the knowledge and skills with the same learning resources during a fixed time period to all the students without considering their individual differences. Moreover, flipped classroom can enhance both FOCHP that focuses on providing passive learning, which may occur before the class while studying the learning material, and SOCHP that focuses of providing an interactive learning, which happens while applying the learnt knowledge (Van Alten et al., 2019).
- Asking help as a skill of self-regulated learning–Van Alten et al (2019) found that, compared with traditional learning, the flipped classroom is more effective in improving self-regulated learning among students.

As for the impact of the flipped classroom on the Second-Order Cognitive Holding Power (SOCHP), previous research has shown the following results:

- Tackling problems - Improves the students' problem-solving abilities (Evseeva and Solozhenko, 2015; Soliman, 2016).
- Trying out ideas - Increases the students' knowledge, skills, positive attitude, attendance in the class sessions, and provides a better participation in the course activities, because the teacher in the flipped classroom helps the students to increase their learning progress (Bishop and Verleger, 2013; Martinelli et al., 2018; Kim et al., 2019).
- Interpreting new situation - The flipped classroom facilitates interpretation of new learning situations while studying foreign languages and Macroeconomics (Hung, 2015; Murillo-Zamorano et al., 2019).
- Learning plans - Self-directed learning approach of the flipped classroom provides the students more time and opportunities to master learning and improves their practical planning skills (Riddle et al., 2019; Xu et al., 2019; Zhu et al., 2020).
- Relating learned content with the existence knowledge - The flipped classroom helps the students deepen their own understanding of what they learn and supports constructive learning, which helps to connect newly learned knowledge with their previous experience (Van Alten et al., 2019).
- Generating new ideas - The flipped classroom enhances the students' learning experience, higher-order thinking skills, creativity, self-efficacy and learning outcomes (Awidi and Paynter, 2019; Barbour and Schuessler, 2019; Jovanovic et al., 2019; Supiandi et al., 2019).
- Problem solving and monitoring - Improves the students' practical skills which include communication skills, which can support monitoring the current level of learning, and inter-professional and inter-disciplinary teamwork, which can support learners to improve their learning (Riddle et al., 2019)
- Students propositional knowledge for interpretation of problems - Flipped classroom can be used for improving practical communication skills, the ability of analyze learning problems, and the ability to think for solving problems (Xu et al., 2019)

- Assessing progress toward goals - Improving nursing skills in China and support communication among leaners and teachers because flipped classroom can improve the spirit of cooperation and communication abilities to express their needs to the teacher and other students (Riddle et al., 2019).

With respect to Equity, previous research has found the following support:

- Design of the flipped classroom provides attractive alternatives - The classroom activities become interesting and engaging when the students have enough knowledge and experience about them (Goh and Ong, 2019).
- Academic practices in the flipped classroom provide systematic help - Akçayır and Akçayır (2018) show that the flipped classroom in an educational system has many advantages, such as improving the students' application skills, developing their ICT skills, providing peer-based learning, enhancing learning in large groups, investing learning time for practice, and decreasing the cost of learning.
- Resourcing in the flipped classroom sets concrete targets for more equity - However, it has been found that the flipped classroom does not improve the students' satisfaction (Van Alten et al., 2019).

All these benefits mentioned above are considered as components of CHP. But to date, there is no proper empirical study to demonstrate that using a flipped classroom can improve CHP for university students.

Using a flipped classroom in higher education assists teachers to meet different needs of students and to help in providing different choices to those students on practicing learning activities. A flipped classroom provides students with immediate, regular and formative feedback (Altemueller and Lindquist, 2017). Moreover, flipped classroom can combine multiple modes of learning and provide active learning in and out of the classroom, which happens while taking notes and discussing them with the teacher or classmates (Van Alten et al., 2019). All these studies suggest that using a flipped classroom may be an effective method for achieving equity between students. However, this issues also needs to be explored empirically.

2.2. Model for creating a flipped classroom

There are many models for using a flipped classroom in administrating learning sessions. Wang (2017) proposed the following model of the teacher and the students' activities in a flipped classroom. In the pre-class stage, the teacher prepares micro-content and monitors the students' pre-study, while the students go to the online Moodle to study the content and use the discussion tools on the Moodle to pose questions. In the class stage, the teacher administers a pre-test to check the students learning, gives a brief presentation about the content of the class, discusses with the students their problems in understanding the learning content, presents new problems related to the topic of the class, interacts with the students to solve new problems, and conducts a post-test. As for the students, they engage in the learning activities: before the end of the class, they are expected to finish all the learning activities, to do a formative assessment, and to share their work with other students. After the class, the students are expected to continue their studies in the form of homework.

Cukurbasi and Kiyici (2018) suggest that a flipped classroom model should include, (1) daily activities like taking responsibilities and communicating with the classmates and the instructor to finish these responsibilities; (2) designing group activities to support many learning activities and gaining many benefits; (3) emotional features that add more excitement and motivation, and make learning more interesting; (4) improving the students' assessment skills so that they can improve their learning; and (5) achieving educational benefits such as providing students' more information and opportunities for planning their learning procedures, managing learning time, and learning by trial and error.

Zhang (2018) proposes that using a flipped classroom for achieving collaborative learning requires ensuring that the students in each group should be balanced across gender, intellectual abilities, learning capabilities, and social skills. Moreover, the differences between different groups should be small. There is also a need to achieve positive interdependence among members: each member should understand his/her responsibilities. A flipped classroom should support face-to-face interaction among the students and the instructor, and enrich the students' social skills. Finally, a flipped classroom should support group evaluation that facilitates sharing of experiences among the students.

Munir et al. (2018) propose that learning in a flipped classroom starts from the outside of educational institutes. The students start learning alone by watching a short video and reading the syllabus of the course, and then each student prepares himself/herself to participate in the class activities. The next step is inside a classroom, where each student co-operates with other students in the class to learn to apply the key concepts and discuss the learning content. The final step is again outside the classroom, and involves thinking critically, replying to the classmates' inquiries and the teacher' questions, and, at the end, reviewing the learning experience.

Based on these prior models of the flipped classroom, the learning process in the current study is indicated in Figure 1, where the students' learning starts outside the classroom. The students study the assigned content for the next class (learning session) by reading some documents or watching some videos. After this, the students have an opportunity to discuss with other classmates any ideas or concepts that they could not understand on a shared network like WhatsApp and can upload what they understood about the syllabus on a shared media (like the Google Drive). This stage outside the classroom focuses on transferring the knowledge and skills to the student. In the next stage inside the classroom, the students do the compulsory tasks/problems provided by the teacher at the end of the syllabus. The teacher gives adequate time for finishing these tasks/problems, and, at the end of the classroom session, provides model answers for them. In the final stage, the students submit the final version of the compulsory tasks/problems via email or by uploading them on the Google Drive. At the end, the teacher sends feedback to all the students through email or WhatsApp.

2.3. Cognitive holding power (CHP)

The term *Cognition* refers to what goes on in our mind when we perform our daily activities, and it includes attention, perception, using language, thinking, remembering, learning, understanding, and decision making (Preece et al., 2002, 74; Malim, 1994). Fook and Sidhu (2015) noted that "*Cognitive challenge is the most critical challenge faced by most of the students in higher education*". CHP is defined as the pressure or the
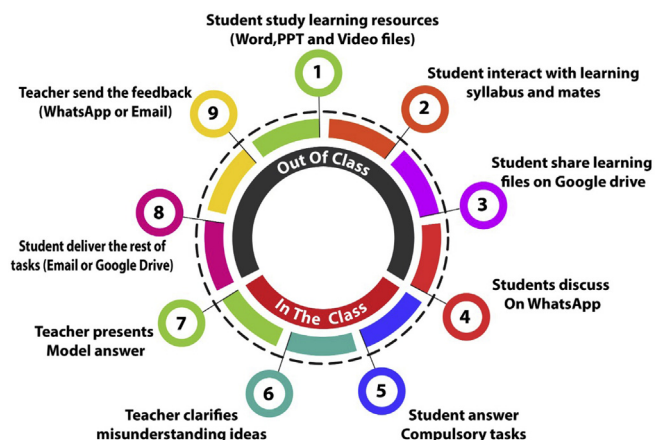

Figure 1. The model of learning in a flipped classroom.

motivation provided by a given situation for the students to engage in cognitive processing (Stevenson and Evans, 1994; Stevenson, 1998). The First-Order CHP (FOCHP) refers to motivating the students into following teachers' instructions, relying on the teacher for establishing connections, copying from the teacher, doing as told or shown while passively accepting new information, and conducting learning activities. The Second-Order CHP (SOCHP) refers to motivating the students into finding new information, making plans for learning, monitoring their learning activities and solving problems.

CHP can increase a student's efficiency in approaching a learning task, and enhance his or her abilities in improving the retention of information and the performance of learning skills. A significant correlation has been found between a student's cognitive abilities and her or his academic achievements. Consequently, enhancing students' CHP is crucial in higher education (Samadi and Davaii, 2012). University students found that it is not easy to study the reading material assigned by the teacher. They faced various cognitive challenges, lacked time management skills, and felt that the teacher did not state her or his expectations and feedback on their performance clearly (Fook and Sidhu, 2015). Improving students' CHP abilities can be an effective solution for these challenges.

Contexts, environments, and teaching procedures all play essential roles in improving a university student's learning and his or her CHP. Different learning environments motivate students at different levels to engage in practicing cognitive activities (Xin, 2008). Walmsley (2003) found that interactive educational environment, such as the flipped classroom, are effective in increasing a student's use of his or her higher-order thinking processes like CHP. Flipped classroom has various features that incorporate the diversity of students' experience, which may make this innovative approach suitable for higher education students (Schwarzenberg et al., 2018). To sum up, we conclude that there is a need to study how various learning environments enhance a student's CHP. In particular, how the flipped classroom, which is considered an effective environment in improving various educational dimensions and provides flexibility in acquiring knowledge and skills, can be an effective learning environment to improve a university student's CHP.

2.4. Equity in learning environments

Equity refers to the attitude of teachers who implement the practice to improve learning, and leads students to be treated as equals. At the same time, equity enhances opportunities for the students who are not well-served by the system (Cochran-Smith et al., 2016). Equity also incorporates students' access to the educational institute and resources, availability of adequate learning activities regardless of their knowledge background, and providing similar responsibilities and guaranteeing equal opportunities for all the students, including disadvantaged students (Castelli et al., 2012). Debnam et al., (2014) note that equity can be defined as the extent to which there is social justice and fair treatment for all the students, and this is critical for ensuring their success. Equity does not just mean treating the students in the same way, but rather treating them all fairly by providing what they need for success.

Nowadays, there is a shift in the direction of development for learning in higher education. Most developing countries are trying to support their educational system by enhancing equity in higher education, for a greater equity can foster and sustain growth (Peercy and Svenson, 2016). Equity in the higher education system is no longer considered a luxury. Each student should have the same chance of accessing the learning resources, asking help and discussing with his or her classmate and the teacher. Accordingly, there are many initiatives to enhance equity in preparing teachers in the faculties of education (Cochran-Smith et al., 2016). Equity should be available in various organizations of higher education, which encompass learning in and out of the classroom, campus life and in establishing a relationship between students and the society. Furthermore, equity has diverse positive effects on improving productivity expectations and enhancing the experiences and knowledge of university' students (Pasque et al., 2012, P. 7).

Achieving equity is not only required for learning, but it is a moral and ethical responsibility. Equity is associated with improving the students' relationship with the university. It promotes both positive academic outcomes and reduces involvement in negative behaviors (Debnam et al., 2014). Enhancing equity in the training programs, which focus on improving the practical skills, can foster the improvement of these skills among the students. Equity is fundamental to the retention of knowledge and the spread of social justice among students in the training program, which benefits all the students (Effland and Hays, 2018). In the Norwegian context, which adopts the "Education for all" principle, the educational system works for enhancing equity regardless of the students' socioeconomic background, and can reduce political problems among the university students and solve the development problems in teaching and learning (Braathe and Otterstad, 2014). In the U.S., future teachers in the educational systems are required to be well prepared for investing the capabilities of the students to flourish country's future (Sleeter, 2008). Therefore, the teachers should be much more aware of what equity is, the importance of enhancing it, and how it can impact social and educational institutions. Equity can be achieved through affording all students access to excellent educational resources and teachers who can build academic learning inside and outside the classrooms (Sleeter, 2008). In Australia, there is a need to study ways of enhancing equity among students (Li et al., 2017).

Many factors have been identified that enhance or hinder equity. For example, in mathematics, there is a relationship between creativity in solving problems and achieving equity. Allowing the students to *discover* solutions of problems helps them to feel that they have the same opportunities for learning in the classroom. But the traditional way of teaching mathematics does not allow the students to critique, evaluate and understand each other's ideas for solving the same mathematical problem. Therefore, the traditional methods of teaching mathematics do not foster equitable interactions among students, which is required to accomplish equity (Kozlowski and Si, 2019; Luria and Kaufman, 2017).

Castelli et al. (2012) argue that equity should provide all students the same opportunity or legally recognized rights; help all students to access the educational institute; apply educational models and measure to all students equally; and provide the same opportunities to all students for accessing the learning resources. A flipped classroom can be a suitable platform for achieving deeper learning, considering the diversity of the students' learning styles and experiences (Goedhart et al., 2019). This can lead to enhancing equity among students (Chiquito et al., 2020). In contrast, one study found that the effectiveness of the flipped classroom depends on the students' gender: female students' results were significantly better on *Technology of Materials* exam than male students. Thus, it is not clear whether flipped classroom can enhance equity among higher education students or not. To conclude this discussion, we note that nations around the world are paying more attention, effort, and time to prepare teachers to be more effective in handling diversity among students and enhancing equity in the educational systems, especially in higher education. Although, there are many known benefits of enhancing equity among university students, little is known about how equity can be improved in digital learning platforms, especially in the flipped classroom.

2.5. Research objectives and questions

The flipped classroom leads to sharing knowledge, solving problems of the traditional learning environments, providing more interesting learning and providing a flexible schedule (Mohamed and Lamia, 2018). It provides an interactive educational environment, which can be a suitable platform for improving students' higher order thinking and motivating them for improving their CHP. In addition, it has the potential to enhance equity, because almost all the students in the flipped classroom can use the same learning resources whenever they access the internet. Also, the flipped classroom can be a good solution for providing better learning opportunities for an increasing number of higher

education students, catering for their learning needs, in spite of a shortage of learning resources and well-qualified teachers. Consequently, it is important to explore additional advantages of using the flipped classroom in an educational system; these advantages can lead to supporting students-centered learning and improving the quality of higher education learning environment. Therefore, the aim of the current study was to study how the flipped classroom impacts CHP and equity among university students. This is stated in the following two research questions:

- RQ1. How does the use of flipped classroom improve university students' CHP?
- RQ2. How does the use of flipped classrooms enhance the equity between university students?

3. Methodology

3.1. Study site

To study the impact of the flipped classroom on CHP and on equity, we focused on an undergraduate course "An Introduction to Instructional Technology" that was taught at the Faculty of Specific Education at the South Valley University in Egypt. This course covers the basics of instructional technology and includes the following topics: (1) The terminology of instructional technology and the main goals of studying it. (2) The components of instructional technology and the relation between it and other education majors. (3) Importance of instructional technology in the educational systems and the main roles of a specialist in it. (4) E-learning. (5) Virtual Learning Environments (Virtual Lab – Virtual Class). (6) Google Applications in education (search engine – Gmail – Google Drive – Google Documents). (7) Google Application in education (Google Hangout - Google Form – Google Sheet). (8) Electronic Test (How can you design an electronic test and how can you choose a suitable platform or application for designing the test?). (9) Achievable improvements by applying instructional technology tools in the classroom. (10) Case studies of applying instructional technology in different educational systems. The experiment was run during the second semester of 2018/2019 and ran over 10 weeks. The lectures took place every Monday in the new building of the Faculty of Specific Education, on the 3rd floor, Class (1) of the Educational Technology Department. Data about the students' performance on evaluation and learning activities was collected.

The experimental protocol was approved by the South Valley University Ethical Approval Committee.

3.2. Learning and communication tools

For this study, it was necessary to use various sources of learning materials such as word files, PPT and video files. Students interacted with the syllabus and shared these materials on Google Drive. Each topic included two or three compulsory tasks. All tasks had to be announced on the WhatsApp group or at the end of the word or PPT files. The students could use WhatsApp to exchange their ideas and experiences, and also could discuss with the professor. After the students were finished with the tasks, they were asked to send them by email or upload them on the Google Drive. The professor sent feedback to the students within 24 h via WhatsApp or email. The WhatsApp group could also be used for motivating students by announcing the names of the students who send the right answers. The classroom lecture depended on the WhatsApp discussion, and any errors or misconceptions found while checking the results of the tasks. The teacher focused on using popular applications that the students could easily access during their learning activity, and that could be combined with traditional methods that rely on data show and whiteboards to present relevant knowledge, the model answer or instructions that lead to the model answer.

3.3. Participants

The study for CHP involved one group of 33 undergraduate students of the educational technology department (25 males, 8 females, average age = 20.9, SD = 1.03). The students were in their first year of study at the faculty of Education at South Valley University (Egypt) in the year 2018/2019, and had not participated in an online course before. All the students were familiar with using e-learning tools, Google applications such as Google Drive Gmail, Google Forms, and WhatsApp, within their mobile or personal computer though they chose different preferences for receiving the learning tasks. The students were all living in the university housing city, with equal access to internet access points or/and Wi-Fi network. If some students did not have their own computer, they had access to shared computers. All the learning material was equally accessible to all the students outside the classroom. For the classroom teaching part, all the students attended the same class and were asked to organize themselves into groups subject to a few constraints: the group size should be between three and five, a team should not have all members of the same gender, or from the same secondary school, or be of the same age. All the students in this study participated voluntarily.

For the study on equity, the group of participants described above served as the experimental group, and we involved another group as the control group of 33 undergraduate students of the educational technology department (18 males, 15 females, average age = 20.7, SD = 1.67). The students were in the same level of study, at the same university, and in the same year (2018/2019) as the experimental group. Participants for the control group were chosen based on their acceptance of answering all the questions in the questionnaire, and the following requirements: they should be familiar with using e-learning tools and should have 24-hour access to the internet, which is usually the case with all the university students. Thirty-one students were living in the university housing city; two students were living outside the university housing but they had their own PC and 24-hour internet connectivity.

3.4. Experimental design

A quasi-experimental design was used to measure the improvement in both the CHP and the equity between undergraduate students using the flipped classroom. For the CHP study, only the experimental group was used. A pre-test was administered to the students, after which the students started their compulsory study for the course "An Introduction to Instructional Technology". Studying this course required using a blended learning approach. Students had to attend one lecture per week. Before the lecture, the students were asked to study the topic of this lecture. In the classroom, the students answered quizzes and practiced learning activities similar to the conventional homework tasks. Here, they could discuss their answers with their classmates and the professor. If they could not finish all the tasks in classroom, they were asked to complete the activities within three days of finishing the learning session. The professor sent feedback to each student within 24 h after receiving the activities and the homework answers. Two days before the next session, the professor sent the model answers to all the students. Outside the classroom, the students were free to learn individually or in groups (of three to five students) before and/or after the learning session. But in the classroom, the discussion was in groups of three to five students. Also, the students used WhatsApp, which helped them to get more information, and to send inquiry about the topic or the activities they had to do. In addition, the professor messaged the students regularly to motivate them to continue studying the course through the learning tools. At the end of the course, the students answered the CHP questionnaires as a post-test.

For measuring the impact of the flipped classroom on CHP, we applied the pretest - posttest research design over one group of students. Interactive Google Forms were used to deliver two questionnaires to assess the students' performance. The questionnaire, based on Stevenson and Evans (1994) contained 30 items. Thirteen of these 30 items were designed to measure the First-Order CHP: these focused on the students'
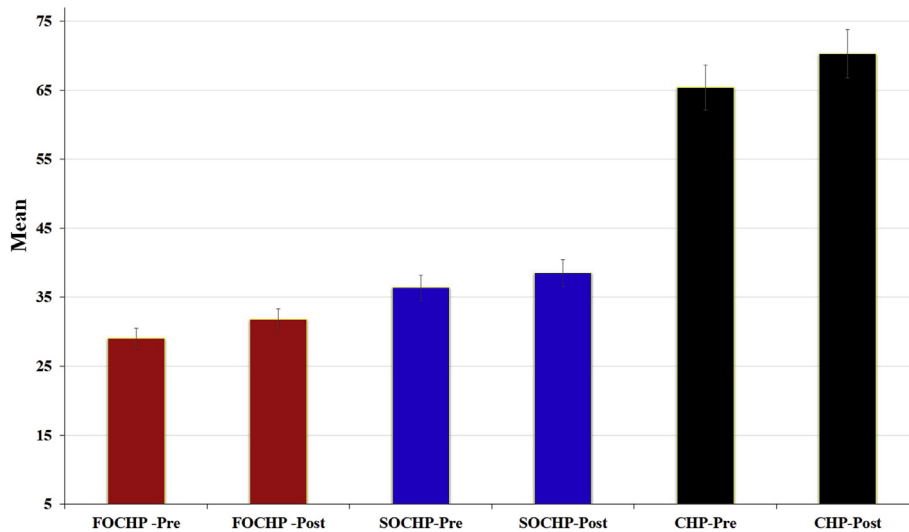
Figure 2. The improvement of cognitive holding power by using flipped classroom.

tendency to do the activities based on the teacher' instructions. Eighteen questions were for measuring the Second-Order CHP, and focused on the students' tendency to learn based on their own responsibility for thinking and learning activities. One question (No. 5) was duplicated in both the FOCHP and SOCHP. The questionnaire used a 5-point Likert scale, with "always = 5" and "never = 1".

Studying equity from the perspective of instructional technology is considered a new topic. Therefore, to judge the improvement of equity while using the flipped classroom, it is necessary to compare the students' response to the equity questionnaire with a control group that did not use the flipped classroom. We asked the students in the experimental group to answer equity questionnaire, which consisted of 10 closed questions focused on measuring three dimensions of equity in the learning environments: the equity of the design of the learning environment, the equity on practicing the learning activities, and the equity on delivering the learning resources. To ensure the efficacy of using the questionnaire, two university staff members working in the educational technology department and one staff member working in the educational psychology department were asked to review the equity questionnaire.

To measure the reliability of the questionnaire, we asked 99 university students in the first year of study at the same university (these did not include the participants in the experimental and the control groups) to fill out the questionnaire and calculated its Cronbach's alpha reliability coefficient, which came out to be 0.73. We compared the questionnaire answers from the experimental group with those of the control group, who studied the same topics using the traditional method. Of the ten questions, four were related to the management of the learning environment, three for measuring the students' academic practices, and three for measuring the availability of learning resources. This questionnaire used a 3-point Likert scale with "available = 3" to "not available = 1". This questionnaire was administered post-test to both the experimental and the control groups, after the course was completed. Each student's score was automatically computed and submitted at the end of answering the Google Form. Analysis of variance (ANOVA) test was used to identify the impact of using the flipped classroom on improving the students' CHP and the equity between university students by comparing the pre-test and the post-test results of the experimental group on the two questionnaires.

4. Results

4.1. Improving the CHP

For measuring the improvement in CHP due to the flipped classroom, we applied the t-test to compare the pre-test and post-test responses of the 33 students who participated in this study (Figure 2). For the First-Order CHP, which focuses on procedures such as: performing tasks and
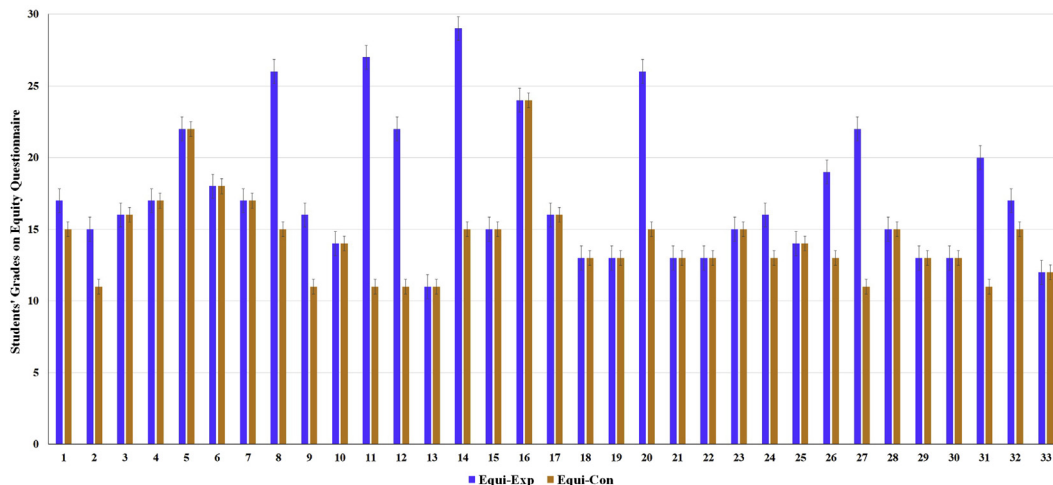

Figure 3. Equity among university students in the experimental and control group.

following teacher' instructions, pre-test (M = 29.00, SD = 7.68) and post-test (M = 31.76, SD = 7.27) showed a significant difference (t = 2.27, p < 0.05). For the Second-Order CHP, which focuses on procedures such as: making plans, exploring learning situations and problem solving, pre-test (M = 36.36, SD = 10.68) and post-test (M = 38.52, SD = 10.75) did not show a significant difference (t = 0.96, p = 0.34). Considering all the CHP questions together, we also did not find a significant difference (t = 1.58, p = 0.12) between the pre-test (M = 65.36, SD = 16.83) and the post-test scores (M = 70.27, SD = 15.99).

4.2. Equity between university students in the flipped classroom

To measure the impact of the flipped classroom on equity, we applied the t-test to compare the post-test scores of the equity questionnaire from the experimental and the control groups (Figure 3). First, we checked the equality between the variances by applying the Levene's test, which showed a significant difference between the control and the experimental groups (f = 7.46, P < 0.01). The t-test also found a significant difference (t = 3.24, p < 0.01) between the equity scores of the control group (M = 14.27, SD = 2.99) and the experimental group (M = 17.45, SD = 4.78).

5. Discussion

5.1. Flipped classroom and CHP

The results of our study indicate that using the flipped classroom significantly improves the First-Order CHP (FOCHP), which focuses on the students' ability to follow the instructions received while studying the course. These results are consistent with the previous research in this direction. For example, Wanner and Palmer (2015) showed that the flipped classroom provides flexible learning and assessment to help university students become more engaged and enjoy the learning activities. It has also been found that the flipped classroom can improve students' satisfaction (Bösner et al., 2015) and increase their creativity, especially with respect to fluency, flexibility, and novelty (Al-Zahrani, 2015). Notice that improving FOCHP does not require improving thinking strategies and students need not try to control the learning procedures, make effort to find a new idea, solve a problem, or monitor their learning procedures. The students only have to follow their teacher and try to do what the teacher asked them (Xin and Zhang, 2009). University students who use blended learning like the flipped classroom can develop their skills by learning through online materials, and their learning experience shows a marginal increase when they have previous experience with digital learning courses. Moreover, students without any experience can quickly engage in learning activities similar to the students who have previous experiences with e-courses (Asarta and Schmidt, 2020).

However, with respect to the Second-Order CHP (SOCHP), our study found no significant improvement in the flipped classroom. The SOCHP goes beyond following the teachers' instructions, and the students are required to use more complex cognitive skills like making plans, solving problems and monitoring the learning procedures. This result is consistent with (Lai and Hwang, 2016) study, which found that students who have higher self-regulation, which require monitoring and managing their goals, showed better learning achievements compared with students who have lower a self-regulation; and monitoring goals is included in the SOCHP. However, our results contradict some prior studies such as Van Vliet et al., (2015), which show that using the flipped classroom leads to an improvement in the students' metacognition skills, self-efficacy and critical thinking, and supports collaborative-learning strategies. Another contradicting study is by Foldnes (2016), which showed that using the flipped classroom leads to organizing various collaborating activities, to decreasing anxiety about the complex practical learning steps, and in general to improved learning efficiency (Teo et al., 2014).

This inconsistency could be due to the fact that that the students in our study were following a compulsory course, which limited their freedom during the study. The students needed to follow the course schedule and the requirements to pass the final exam, and typically they tend to follow the teachers' instructions to get better marks. In this situation, the students do not need to make any plan for studying or to monitor their achievements because they are continuously receiving feedback from the teacher.

5.2. Equity in the flipped classroom

The results of our study show that students in a flipped classroom feel a better equity among themselves compared to students in a traditional classroom. This could be attributed to the continuous availability of the instructional resources, and the opportunity for all the students to discuss with the instructor not only in the class but also through various digital learning platforms. Besides, the periodic assessment of the students' progress and the feedback sent to them helps to improve their learning experience. At the same time, the flipped classroom gives the students various chances to discuss with the instructor, which can lead the students to a deep understanding for the main reasons behind receiving positive or negative feedback.

Enhancing equity is premised upon the means by which teachers understand the students' features and needs (Lopez and Olan, 2019). Moreover, enhancing equity requires a suitable context and curriculum, planning for the learning activities, preparation for the learning infrastructure, suitable policies, and an appropriate learning environment, which can be the flipped classroom (Effland et al., 2020). Previous studies suggest a relationship between equity and forms of social interactions that support the freedom in learning and students' capabilities, but current educational systems have found it difficult to build this relationship (Unterhalter, 2009). Based on these studies, we can understand why the flipped classroom can lead to improved equity. Also, the flipped classroom can improve the students' achievement, increase their learning motivation (Bhagat et al., 2016), improve their skills and knowledge (Bösner et al., 2015), and support collaborative-learning strategies (Van Vliet et al., 2015). In general, collaboration in digital learning gives more responsibility for learning to the students, resulting in better equity between them.

To further understand how the flipped classroom improves equity, Nguyen et al. (2016) suggest that a flipped classroom adds flexibility and transparency in learning activities for both the students and the teachers during the preparation and the interaction. The flipped classroom facilitates a positive attitude in the students toward learning activities and self-evaluation (Chao et al., 2015). Moreover, the flipped classroom helps the students to be more committed to sustainable development (Buil-Fabregá et al., 2019), which can be a natural result of repeating the use of learning resources in the flipped classroom (Tomas et al., 2019). A combination of these factors keeps a majority of the students motivated and prevents dropouts from the flipped classroom.

6. Conclusions and future research

In this study, we explored the impact of the flipped classroom on improving CHP and enhancing equity among university students. As far as we are aware, this is the first such study. Our results show that the flipped classroom improves the FOCHP of the students. These results should be interpreted in the context of the prior studies, which showed that the flipped classroom can improve the students' attendance to the class sessions, and can avoid their rejections of the learning activities. Although these prior studies suggested that the flipped classroom can increase students' skills of higher-order thinking and their self-efficacy, we did not find a significant improvement in SOCHP. This could be because of the limited way in which we implemented the flipped classroom for our study. For example, it was a compulsory course with a rather rigid curriculum, which did not leave much room for the students

to exercise their SOCHP. Accordingly, a future study should pay attention to providing suitable learning activities that give the students more responsibilities about their learning. For equity, we found that the students in the flipped classroom feel that they have more equal and fair access to the resources than in a traditional classroom. The main reason behind this could be that in the flipped classroom the teacher has better opportunities for investing his/her time for interacting with the students, so the teacher can answer their questions and support them in solving problems. This may lead the students to notice they all have equal opportunities to learn better. At the same time, our results highlight the importance of providing various types of learning resources such as audio, videos, documents and interactive learning applications.

The current study was a preliminary study, and so has some limitations. One is that the number of participants was small. Another is that we did not conduct the CHP questionnaire with the control group. The course duration was also short (one month). In spite of these limitations, the results are useful for designing a flipped classroom to improve the level of equity and CHP among the university students. Also, the popular applications and the simple research procedures used in our study can encourage teachers and professors to follow this methodology to apply the flipped classroom inside their courses. Overall, the results of our study are encouraging and we expect future research to consolidate them by addressing the shortcomings of our experiment. For example, more study is needed to assess the effect of the flipped classroom on the SOCHP. Also, further research is needed to investigate whether flipped classroom can enhance equity among students on the other educational stages like pre-school, primary and secondary education.

Declarations

Author contribution statement

M.M.H. Ahmed: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

B. Indurkhya: Analyzed and interpreted the data; Wrote the paper.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

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