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Using a Modified Online Jigsaw Technique to Address Covid-19 Related Topics During the Pandemic Lockdown

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Abstract: With the traditional jigsaw technique, small groups are formed with each student having a piece of information needed to complete the assignment. Next, groups of students with the same information meet to explore their material before returning to their home group to complete the assignment. This study sought to determine the efficacy of a modified jigsaw form where students received their individual material two days before class discussions and submitted preparatory work, therefore omitting the opening group. This modified jigsaw was used in two online courses, one synchronous and one asynchronous. A random sample of 50% of the jigsaw assignments from the synchronous class (n = 15) and the asynchronous class (n = 20) were coded utilizing Bloom's revised taxonomy (Anderson & Krathwohl, 2001) and Fink's (2013) learning types as predetermined codes. Online jigsaws were then compared to each other, then to a recent face-to-face-application (n = 110). Results were generally positive. All three indicated Bloom's applying level but with both online jigsaws significantly higher than the face-to-face sample, $F(2,793) = 16.282$, $p = <.001$. Concerning learning types, both online classes produced the expected integration of materials necessary for the jigsaw. However, the asynchronous jigsaw mean was significantly lower than the synchronous one, and neither differed significantly from the face-to-face section. Concerning student satisfaction, all three sections were positive, scoring well over 4.0 out of 5.0, though the asynchronous application was significantly lower than the face-to-face group. Multiple examples from the assignments are used to further elaborate the results.

Keywords: jigsaw technique; collaborative learning; types of learning; critical thinking; online learning

Learners need time to understand complex or novel ideas (Woods, 2019) and most need to interact with new information several times before it becomes usable knowledge (Socol et al., 2019). New material is learned best when it is thought about deeply and associated with something already known, and both actions can result from students purposefully working together (Zakrajsek, 2012). Cooperative learning actively facilitates such learning (Calkins & Rivnay, 2021; King, 2012a) using personal accountability and group interdependence (Dashner & Berg, 2021). This can be achieved through focused interaction, enabling students to learn from, and teach, each other to produce a shared outcome (Chang & Benson, 2022; King, 2012b; Nusrath et al., 2019; Yoshida, 2018). "The *jigsaw* is a cooperative technique that seeks to intentionally combine critical thinking with collaborative learning through reflection and discussion of ideas" (Dashner, & Berg, 2021, p. 2) and to effectively introduce more material in a short time (Woods, 2019). This

group activity utilizes a problem-solving with peer-teaching aspect of cooperative learning (King, 2012a) to promote an inclusive learning environment where information is broken down into manageable pieces with each piece assigned to a group member, providing "an opportunity for students to collaborate, engage in critical thinking, and reflect on the experience" (Dashner & Berg, 2021, p. 3). Ongoing research indicates that the jigsaw technique has a consistently positive influence on learning (Chang & Benson, 2022; Suwiwa et al., 2022). Although online results have been mixed (Landrum et al., 2019) they are generally positive (Chang & Benson, 2022). This study seeks to determine if online results using a modified form of jigsaw are likewise beneficial.

Literature Review

Aronson et al. (1978) created the jigsaw technique to help build collaboration and community in classrooms following the desegregation of schools. They wrote, "It would be valuable if the basic process could be changed so that children could learn to like and trust each other not as an extracurricular activity but in the course of learning…" (p. 23). It is now one of the most used forms of cooperative learning (Costouros, 2020) although it is used less in higher education and may be new to many students (King, 2012a).

In its original form (Aronson et al., 1978), the jigsaw begins with the overall topic and goals for the assignment introduced by the instructor. Next, home groups are formed with each member assigned a part of the necessary information to master (Aronson, 2021). Students then briefly discuss the assignment and how their information, or puzzle piece, will fit into the assignment. These groups then break apart with students moving from their home group into new, expert groups consisting of members from each group who share a common piece of information (Aronson, 2021). Here, learners examine their specific information, address related questions, and seek to develop mastery of their material (Costouros, 2020; Dashner & Berg, 2021), with each student contributing from their own experience, resources, and skills (King, 2012b). As peers explain and share insights with one another, this personal elaboration of knowledge, another learning strategy within collaborative learning, serves to engage and strengthen critical thinking (Dashner & Berg, 2021) and prepare these experts to teach their home group members (Aronson, 2021; Socol et al, 2019). Students then return to their home groups, like puzzle pieces, with each expert taking responsibility for sharing their new knowledge with their original team members (Aronson, 2021). The goal being for all to be involved and help one another learn the content effectively and to make all members equally responsible for the group's success (Dashner & Berg, 2021; Calkins & Rivnay, 2021). "Once each member of the home group has taught their piece of the puzzle to the other members of the group, the whole puzzle is formed" (Costouros, 2020, p.156), and the students are prepared to take the quiz or complete the assignment. However, the jigsaw technique is quite adaptable with many potential variations (Anderson et al., 2022; Costouros, 2020).

Most results from jigsaw learning are positive with evidence of improved academic performance (Anderson et al., 2022; Chang & Benson, 2022; Nusrath et al., 2019).

This success is largely due to the jigsaw's capacity to engage students twice, once in a group with common material and again where they teach their material to peers (Aronson et al., 1978). Also, and in agreement with Aronson et al.'s (1978) original work, studies have credited the jigsaw method with more active participation among college students and increased confidence as students and scholars (Nusrath et al., 2019). But of greatest relevance here are reports of higher order analysis (Anderson et al., 2022; Nusrath et al., 2019) and more frequent usage of critical thinking (Suwiwa et al., 2022) that extends even to those students who may be less intrinsically motivated (Woods, 2019).

Student satisfaction is critical in assessing the quality of online education (Xu & Xue, 2023). Students generally report satisfaction with the jigsaw (Anderson et al., 2022; Calkins & Rivnay, 2021) with most viewing it as effective support to learning and indicating they understood the value of the assignment (Zakrajsek, 2012). Indeed, "the majority of students enjoy working in groups and getting to know each other" (Boothe & Lohmann, 2020, p. 298). However, group work only becomes authentic cooperative learning when students make intentional effort to bring the learning of all group members to the highest level (Dashner & Berg, 2021), and results there are mixed. While Chang and Benson (2022) reported students favoring a jigsaw over lecture, others found no significant difference in student satisfaction between the two methods (Costouros, 2020; Nusrath et al., 2019), and still others reported that "some students resist anything that even resembles group work" (Zakrajsek, 2012, p.1). Studies showing less satisfaction with the jigsaw appear most related to students simply not enjoying group work (Weimer, 2017). It does typically require more concentrated effort, and some students may then perceive it as harder than working alone (Weimer, 2017). Also, those who do not enjoy group work may not put forth their best effort (Costouros, 2020; Nusrath et al., 2019), limiting the success with, and satisfaction of, the jigsaw assignment for other students. Unsurprisingly then, the most reported detriments are ineffective communication and lack of individual preparation (Weimer, 2017, 2020). The latter being consistently identified as a leading cause of difficulty when using the jigsaw technique (Brindley et al., 2009; Chang & Benson, 2022; Costouros, 2020; Nusrath et al., 2019; Weimer, 2017).

Computer supported collaborative learning is still a new area of study (Chang & Benson, 2022) and although online courses are sometimes criticized for not better engaging students (Amador & Mederer, 2013), results are optimistic (Landrum et al., 2019; Suwiwa et al., 2022; Thieu et al. ,2022). Although research specific to the jigsaw technique is even more limited, Suwiwa et al. (2022) found student satisfaction with the online application of the jigsaw technique to be noticeably positive. Another recent study, Mitchell et al. (2022), found most students (77.3%) to be somewhat or very satisfied with the jigsaw, with many adding that the experience improved their understanding of class material. Although Costouros (2020) cautioned that "higher student satisfaction is not necessarily indicative of learning" (p. 159), jigsaw learning outcomes online are encouraging, having been shown to improve participation and knowledge sharing (Chang & Benson, 2022). In fact, research indicates that an online jigsaw can support Aronson et al.'s (1978) original intent to explore cultural distinctions and produce opportunities for social

connection (Chang & Benson, 2022). Furthermore, online jigsaws may outperform traditional classroom application in some cases. When Amador and Mederer (2013) sought to retain their goals for the jigsaw in classroom usage online, they described the online jigsaw discussions as generally of higher quality. Recent studies report comparable results (e.g., Chang & Benson, 2022; Sadaf et al., 2021; Suwiwa et al., 2022; Thieu et al., 2022). Nevertheless, as with face-to-face jigsaw learning, lack of preparation is seen as the leading reason for student satisfaction in online application as well (Brindley et al., 2009).

Still, as with group work (e.g., Zakrajsek, 2012), it is probable that some students simply do not like online courses. Xu and Xue (2023) reported that student satisfaction had steadily decreased over the past 20 years with 79.7% of students reporting satisfaction with online learning prior to the Covid-19 pandemic and decreased further with the sudden shift to emergency online learning during the lockdown. Indeed, a recent meta study indicated a sizable drop in satisfaction to only 62.3% satisfied with this learning (Xu & Xue, 2023).

Student satisfaction may also vary between synchronous and asynchronous online learning. Although there is little research available, students are generally positive about both (Alzahrani et al., 2023), but results vary. For instance, Fabriz et al. (2021) found that students reported more satisfaction with mostly synchronous classes. Xu and Xue (2023) agreed, though their results were insignificant. However, Alzahrani et al. (2023) found no difference between the two. Also, some reported no difference between the two methods concerning student learning gains (Fabriz et al., 2021; Xu& Xue, 2023).

Purpose of this Study

This case study sought to assess the student satisfaction and learning value of a modified jigsaw technique in two online classes during the pandemic lockdown, one mostly synchronous and one mostly asynchronous. Results were then compared to the same method used in traditional classes by Anderson et al. (2022). This modified jigsaw is like Aronson's (2021) original form previously described, but given the importance of individual preparation (e.g., Benton, 2016; Weimer, 2017, 2020), the initial home group was omitted, and the general topic was introduced in the class prior to the actual assignment. Students were assigned one of six different articles on a common topic to prepare. Following Benton's (2016) recommendation, students submitted, prior to class, a brief review of their material, 3-4 bulleted statements of information they found significant or unfamiliar and why, and 2-3 pertinent questions prepared for their initial, expert group using common material. After approximately 30 minutes of refining their points for discussion in their expert group, students moved to their mixed, home group where they taught their material, responded to questions, and were introduced to related information by their peers. This was also approximately 30 minutes. The final 10-15 minutes of the class were used to debrief and begin preparing individual responses due before the next class. This also differs from the traditional jigsaw's group assignment or quiz but still involved accountability and cooperating toward a common educational goal

(e.g., Yoshida, 2018). Measures here included student satisfaction with the jigsaw, level of student thinking and processing, and learning types used.

Methods

This modified jigsaw assignment was used in two fully online courses in the Human Development and Family Sciences major. The first class, *Multicultural Family Studies,* was mostly synchronous (*n* = 30), with regular online lectures, discussion, and presentations. Most students were juniors (57.1%), followed by 40.2% seniors and 2.7% sophomores. Most identified as European American (76.7%), 13.3% as Latinx, 10.0% as African American. The second class, *Couple Relations*, was mostly asynchronous (*n* = 40). Again, most were juniors (50.4%), with 48.1% seniors and 1.5% sophomores. Most were European American (70.0%), 12.5% African American, 10.0% Latinx, 5.0% were of Middle Eastern descent, and 2.5% identified as Asian American. All students were female.

The synchronous online jigsaw (SOJ) was introduced in the class before the actual assignment while the asynchronous online jigsaw (AOJ) was introduced in an online module. Otherwise, they did not differ from each other, with students meeting via ZOOM the day of the assignment for expert and home groups. Both were taught by the same teacher. A random sample of 50% of the modified jigsaw assignment from each class was selected for analysis then compared to the face-to-face jigsaw taught by the same instructor at the same institution the previous year (Anderson et al., 2022).

Measures

Student satisfaction is likely predictive of student achievement (Costouros, 2020; Nusrath et al., 2022; Suwiwa et al., 2022; Xu & Xue, 2023) and will be assessed using confidential student feedback from the *Individual Development and Educational Assessment* (IDEA) (About IDEA, 2023) instrument. The IDEA was designed to assess progress on specified teaching and learning objectives. Results are reported on a 5-point scale: 1 = No apparent progress; 2 = Slight progress; 3 = Moderate progress; 4 = Substantial progress; 5 = Exceptional progress. The three, of 32, IDEA objectives grouped together as "Fostering Student Collaboration" and considered most applicable to student satisfaction with the jigsaw technique will be considered here. These include (IDEA notes on instruction, 2023):

1. Formed teams or discussion groups to facilitate learning.
2. Asked students to share ideas and experiences with others whose backgrounds and viewpoints differ from their own.
3. Asked students to help each other understand ideas or concepts.
4. Helped students to interpret subject matter from diverse perspectives. (e.g., different cultures, religions, genders, political views)

With student satisfaction understood as perceiving "online learning as an effective method for acquiring knowledge" (Xu & Xue, 2023, p. 9) and jigsaws often based

on course learning outcomes (Sadaf et al., 2021), a fourth IDEA item directly reflecting an objective for both courses was also included. This was compared to an item in older versions of the IDEA (King, 2012b) completed by students but not used in Anderson et al. (2022), which read, asked students to share ideas and experiences with others whose backgrounds and viewpoints differ from their own.

Anderson and Krathwohl's (2001) revision of Bloom's taxonomy of educational objectives is a well-established hierarchical continuum with each higher level representing increasing cognitive complexity. All levels will certainly be used to varying degrees as "most authentic academic tasks require the coordinated use of several cognitive processes" (Anderson & Krathwohl, 2001, p. 89) to create meaningful knowledge. However, applying the taxonomy will also determine the levels of cognitive processing most used to complete the jigsaw assignment. Briefly described, from least complex to most, the levels are:

1. Remembering – exhibiting memory of previously learned information
2. Understanding – demonstrating previous learning by connecting
3. Applying – using existing knowledge or creating new skills, to solve problems
4. Analyzing – breaking down existing knowledge and examining specific parts
5. Evaluating – presenting informed judgments and justifying a position
6. Creating – elaboration used to put information together in new ways

Types of learning used by students to complete the jigsaw assignment will also be identified using Fink's (2013), *Taxonomy of Significant Learning.* This was selected to determine the approach most used by students to complete the jigsaw assignment as it goes "beyond the cognitive domain of Bloom's taxonomy and beyond cognitive learning itself to determine what kinds of learning are resulting from the assignment" (p. 34). Another distinction from Bloom's taxonomy is that types of learning are interdependent as opposed to hierarchical. Therefore, "achieving any one kind of learning simultaneously enhances the possibility of achieving the other kinds of learning as well" (Fink, 2013, p. 37). Types of learning include:

1. Foundational knowledge – concerns valid remembering and understanding of information and ideas.
2. Application – involves using and developing skills and when to appropriately apply them.
3. Integration – noticing, identifying, and understanding the connections between things.
4. Human dimension – describes learning about self and others to increase effective interaction.
5. Caring – a focus on developing new interests and feelings.

6. Learning how to learn – results in a deeper understating of learning itself and becoming a more effective learner.

Coding and Analysis

The case study approach is a thorough interpretive study of a specific instance in an authentic setting (Bishop-Clark & Dietz-Uhler, 2012; Yin, 2018) and has been found effective in examining educational methods (Hamilton & Corbett-Whittier, 2013). Because case studies in education can be difficult to understand objectively when considering a single assignment (Hamilton & Corbett-Whittier, 2013), as is the case here, triangulation of multiple measures of the same event is an essential, though underused, element in the Scholarship of Teaching and Learning (SoTL) (Divan et al., 2017). Therefore, Krathwohl's (2009) multimethod-multimeasure model, used previously to assess this jigsaw in face-to-face settings (Anderson et al., 2022), is applied here. The multimethod requirement will include examining the same assignment in multiple classes. Multimeasures will involve the three independent items introduced above. This triangulation of measures should limit the possibility that findings could be dependent on any single measure (Krathwohl, 2009; Yin, 2018), offer a more reliable conclusion (Bishop-Clark & Dietz-Uhler, 2012), and strengthen construct validity (Yin, 2018).

The role of theory, like triangulation, has also been often neglected in SoTL work (Divan et al., 2017). However, there is evidence that case studies in education can be strengthened with relevant theory (e.g., Anderson, 2019; Anderson et al., 2022). Yin (2018) specifically reported that analyzing data with the theoretical model(s) that led to the design of the study, Fink (2013) in this case, could produce reliable evaluation and findings. While such **thinking with theory** is unusual in SoTL research, it enables one to apply, or borrow from, multiple models to pursue qualitative inquiry as less a scripted method and more as a progression of discovery (Denzin & Lincoln, 2018). Findings from all three measures above were compared to the application of the same modified jigsaw face-to-face (Anderson et al., 2022) using a one-way ANOVA. A post hoc Tukey HSD test was used in pairwise comparison to better determine the source of any difference.

Student satisfaction will be assessed using student feedback for the four previously identified items from both classes. These will be reported and compared with each other and those from the face-to-face application (Anderson et al., 2022). It was expected that each IDEA item (2023) here would be comparable to the same jigsaw format used in traditional classes (Anderson et al., 2022) or somewhat lower, as with Xu and Xue's (2023) emergency online learning.

Next, a random sample of 50% of the jigsaw assignments from the two online classes were coded by two independent reviewers for level of cognitive processing (Anderson & Krathwohl, 2001) and type of learning (Fink, 2013). The goal being to explain student work by comparing the results of the coding, an **observed pattern**, with the pre-determined and **expected theoretical patterns** of Anderson and Krathwohl (2001) and Fink (2013). The greater the similarity between observed and expected patterns, the greater the internal validity (Yin, 2018). This pattern-

matching technique is explicitly designed for this and is recommended for use in case studies (Pearse, 2019; Yin, 2018) and was used successfully in previous, related research (e.g., Anderson, 2019; Anderson et al., 2022). Coding continued until a kappa score of >0.61 (McHugh, 2012) for intercoder reliability was determined using the intra-class correlation coefficient function of SPSS v.26.

Two independent coders utilized the terminology of Bloom's revised taxonomy (Anderson & Krathwohl, 2001) to identify levels of thinking and processing used during the assignment. Descriptors for each taxonomy level were selected from the *Quick Flip Questions for the Revised Blooms Taxonomy* (Quick Flip Questions, 2017) to better clarify coding application. These are listed in Table 1 below.

Table 1

Jigsaw Assignment Coding Scheme for Bloom's Revised Taxonomy

Code	Taxonomy level	Descriptors
1	Remembering	Telling, recalling, recognizing, defining
2	Understanding	Comparing, contrasting, interpreting, explaining
3	Applying	Implementing, utilizing, making use of, identifying
4	Analyzing	Attributing, identifying motives, distinguishing, inferring
5	Evaluating	Compare, interpreting, critique, supporting, discover
6	Creating	Elaborating, predicting, imagining, proposing

Two independent coders then utilized the terminology of Fink (2013) to identify types of learning. Descriptors used in assessing this jigsaw are listed in Table 2 below.

Table 2

Jigsaw Assignment Coding Scheme for Types of Learning

Code	Learning type	Descriptors
1	Foundational	Basic facts and understanding major ideas
2	Application	Applying or learning a new skill or way of learning
3	Integration	Connecting new ideas, experiences, information
4	Human Dimension	Learning about self or others; societal implications
5	Caring	Developing interest or seeing value in the subject
6	Learning to Learn	Understanding the process of learning; motivated

It should be noted that **integration** bears a clear similarity to jigsaw learning, requiring the perceiving and connecting of "one body of knowledge with other ideas and bodies of knowledge" (Fink, 2013, p. 86). Therefore, a mean score of 3.0, integrations was anticipated. However, it was likely that one or two other types may be obvious in secondary roles.

Results

Student Satisfaction

Students were satisfied with the online assignment and felt it added to their learning. However, both online applications were rated lower than the face-to-face jigsaw (Anderson et al., 2022). Means for each item in each class are listed in Table 3 below.

Table 3

Student Satisfaction Results Compared

IDEA Objective	Synchronous online jigsaw	Asynchronous online jigsaw	Face-to-face jigsaw
#1	M = 4.13, SD = 0.46	M = 3.55, SD =1.08	M = 4.80, SD = 0.10
#2	M = 4.75, SD = 0.43	M = 4.00, SD = 1.04	M = 4.90, SD = 0.00
#3	M = 4.50, SD = 0.71	M = 4.18, SD = 0.94	M = 4.70, SD = 0.05
#4	M = 4.50, SD = 0.71	M = 4.45, SD = 0.78	M = 4.79, SD = 0.70

Results from a one-way ANOVA of the three applications, SOJ (M = 4.47, SD = 0.256), AOJ (M = 4.05, SD = 0.378), and face-to-face (M = 4.79, SD = 0.399), were significant, $F(2, 9) = 7.723$, p = .011. A *post hoc* Tukey HSD test for multiple comparisons found that the mean value of IDEA measures was significantly different between the AOJ and the face-to-face group (p = 0.009, 95% C.I. = -.1043, .9543). There were no other statistically significant differences in mean scores at p = .05.

Cognitive processing and reasoning

Table 4

Taxonomy Levels in each Jigsaw Setting

Taxonomy Level	Synchronous online jigsaw	Asynchronous online jigsaw	Face-to-face jigsaw
1 Remembering	6.0%	16.0%	8.5%
2 Understanding	25.0%	26.3%	40.1%
3 Applying	11.2%	27.7%	18.8%
4 Analyzing	21.6%	17.8%	20.6%
5 Evaluating	32.8%	4.2%	9.8%
6 Creating	3.4%	8.0%	2.2%

A random sample (n = 15) from the SOJ was coded (k = .776), resulting in a mean of 3.50 (SD = 1.404), indicating the applying level. However, a mode of five indicated the greatest number of responses at the evaluating level (32.8%) with only 11.2% at the applying level. Similarly, the AOJ (n = 20) yielded a mean of 3.32 (SD = 1.572) (k = .811), also at the applying level. A mode of three confirms this with 27.7% of the responses. As anticipated, both means were above the remembering level and like Anderson et al. (2022), (M = 2.9, SD = 1.236). However, the face-to-face sample yielded a mode of two indicating most responses at the understanding level (39.9%). Although quite similar in mean score, the modes were different in all three groups, as were the distribution of coded responses across the taxonomy. Refer to table 4 below.

Results from a one-way ANOVA were significant, $F(2,793) = 16.282$, $p = <.001$. A post hoc Tukey HSD test for multiple comparisons found that, although all three means indicated applying, the mean value of both the SOJ ($p = <0.001$, 95% C.I. = -.38, 1.01) and the AOJ ($p = 0.003$, 95% C.I. = -.1043, .9543) differed significantly from the face-to-face sample. The online jigsaws yielded higher mean scores than the face-to-face group but did not differ significantly from each other at p = .05.

Types of learning experienced

As predicted, and in agreement with Fink's (2013) view of the learning types as wholly interdependent, all types were present at varying levels in the assignment. A random sample from the SOJ (n = 15) (k = 0.713) produced a mean of 3.32 (SD= 1.572), and a mode of 3 (26.6%), strongly indicating **integration** learning as expected. There was also a notable amount of learning of the **human dimension** type (17.8%). The random sample from the AOJ (n = 20) (k = 0.802) resulted in a mean score of 2.86 (SD = 1.419) and a mode of 3. Again, integration learning was primary (27.7%), though with an almost equal amount of application learning (26.3%). Both online jigsaws were comparable in these respects to the face-to-face group (M = 3.09, SD = 1.109) and a mode of 3. Refer to Table 5 for all learning types used.

Table 5

Learning Types Used in each Class

Types of Learning	Synchronous online jigsaw	Asynchronous online jigsaw	Face-to-face jigsaw
1 Foundational	17.0%	17.8%	9.7%
2 Understanding	13.3%	26.3%	19.2%
3 Integration	36.6%	27.7%	31.9%
4 Human Dimension	17.8%	16.0%	31.3%
5 Caring	14.1%	4.2%	7.1%
6 Learning to Learn	11.1%	8.0%	0.6%

However, a one-way Anova was significant, $F(2, 849) = 8.849$, $p = .004$. A post hoc Tukey HSD test found the mean value of the SOJ significantly different from the AOJ ($p = <0.009$, 95% C.I. = .13, .79). Neither online class was statistically different from the face-to-face sample at $p = .05$.

Discussion and Limitations

Student Satisfaction

The SOJ and AOJ did not differ significantly concerning student satisfaction. Both indicated satisfaction with the jigsaw, in agreement with Chang and Benson (2022) and Suwiwa et al. (2022). However, though some have reported that online jigsaws may surpass face-to-face application (Amador & Mederer, 2013; Suwiwa et al., 2022), that was not the case here. Both online classes scored lower than the face-to-face group with the AOJ scoring significantly lower. This point is consistent with those reporting greater student satisfaction in synchronous online courses (e.g., Fabriz et al., 2021; Xu & Xue, 2023). Although lower satisfaction in asynchronous courses may be partially due to students reporting less interaction and support (Alzahrani et al., 2023; Fabriz et al., 2021) or experiencing an increased demand for self-discipline (Xu & Xue, 2023). The latter point could be related to Brindley et al.'s (2009) observation that lack of preparation lowers satisfaction in online classes.

However, results here likely exhibit a more apparent relationship with the abrupt change to online learning in 2020, where student satisfaction dropped significantly compared to pre-pandemic studies (Xu & Xue, 2023). This decline was even more obvious when compared to online courses that were planned and began before the pandemic (Xu & Xue, 2023). Those classes reported 79.5% student satisfaction while those abruptly forced online with less preparation time, the previously mentioned emergency online learning, reported 40.6% satisfaction. Given that the samples for the online classes here (n = 31) and for the face-to-face sample (n = 34) are close in size, emergency online learning seems the most directly plausible explanation.

Cognitive Processing and Reasoning

As predicted, mean scores based on the revised taxonomy for both online classes indicated thinking and processing at the applying level (Anderson & Krathwohl, 2001), in agreement with the face-to-face classes (Anderson et al., 2022). However, the online group means were significantly higher than the face-to-face sample and seemingly in agreement with recent work reporting better jigsaw results online (Chang & Benson, 2022; Sadaf et al., 2021; Thieu et al., 2022). Most statements coded at the applying level reflected students implementing known techniques or existing knowledge to gain insight from the jigsaw experience and produce the completed multi-piece assignment. Many of these responses revealed the applying level as identifying connections to information previously discussed in

class. Some of these insights also come in the form of questions. Examples from the SOJ include the following:

> The first article pointed out that Covid-19 death rates for people of color were much higher than White Americans… I recalled our discussion of the Tuskegee experiment and healthcare available on some reservations. It finally clicked for me.
>
> We found it very odd that this [Tulsa Race Massacre] was such an important part of Black history but never mentioned in a single history book we read in school. This made me think of the Tuskegee experiment. Why have we never been taught this?

A few notable comments were at the analyzing level, accounting for 21.6% of the responses. Here, students were discovering new information and seeking to understand motives for situations and actions.

> These non-peered reviewed articles showed me our country's mindset. But we need to know more so we don't become another byproduct of ignorance. We are the generation that should respond in action to these problems. We can enact change first within our own lives and in our professional lives.

Although the AOJ yielded a significantly lower mean than the SOJ, it also indicated Anderson and Krathwohl's (2001) applying learning. Responses again were supported by thoughtful use of previous class material.

> …successful relationships happen when both partners put in the effort to develop a deeper connection and try to be kind even when it's hard to do in lockdown. Isn't this Sternberg's intimacy? I think developing this response could also be the Interdependence Theory.
>
> Is it possible for a couple that is not isolating together during Covid to form a lasting relationship? The articles didn't address this. Couldn't this be similar to long-distance dating?

As with the SOJ, students also produced insight beyond applying. This statement indicates the evaluating level (17.8%) by prioritizing ideas and actions.

> …remember you're not the only person going through this pandemic. Take time for more family time and focus on your self-care while being understanding with your partner. For me, going outside and enjoying nature while practicing social distancing helps.

Types of Learning Experienced

As expected, both SOJ and AOJ means and modes indicated integration and in agreement with the face-to-face sample (Anderson et al., 2022). Fink (2014)

further described integration as identifying interactions between fields of knowledge, diverse people, or different walks of life, stating, "when students are able to see and understand the connections between different things, an important kind of learning has occurred" (p. 36). One result is a growing skill in interdisciplinary thinking and learning.

With the SOJ, the jigsaw articles focused on recent findings and reaction pertaining to Covid-19 in cultural settings, as well as one historical article concerning minority populations in a search for justice. Those described in the jigsaw articles varied by ethnicity, access to healthcare, historical beliefs, and socio-economic status. Concerning Fink's (2014) integrated interactions mentioned above, for this multicultural studies class, these involved history, policy, and family science.

> Black Americans continue to face struggles because of the color of their skin. We see this in article #3, describing when the voting rights act began in 1965, and what is happening today. In 1921, in article #5, with the massacre in Tulsa, the fire department did not give aid to the predominately African American neighborhood. In article #4, I saw mass shootings labeled differently when committed by a white person and person of color. In one instance it's mental illness and the other it is terrorism. There is still so much work to be done.
>
> My article about the Tulsa race massacre described something that happened long before the other articles. At first, I thought I must have the wrong article. Others were more recent, discussing vaccine acceptance, John Lewis, and Black Lives Matter. I felt lost and that my information didn't fit. Another student pointed out that what we see today has been occurring for a long time. She said what happened in Tulsa in 1921 could happen again. When she said this, it seemed obvious.

The response above seems to exemplify the value of integration learning. The students "are seeking to create hitherto absent connections and integration among different people and different ideas" (Fink, 2014, p. 50). This new insight "gives learners a new form of power, especially intellectual power" (Fink, 2014, p. 36). He describes this resulting power as having the potential of removing walls and the isolation of students from each other and binding academic studies to the student's own life.

As expected, Fink's (2014) integration with the AOJ (27.7%) in the couple relationships class, also contained connections between the articles and the class text as shown in the example below.

> …my assigned article incorporated John Gottman's research from the text explaining how couples should have five positive gestures for every one negative gesture to keep balance in the relationship.

However, many integration responses in the AOJ were different from the one above in that they also included more connections to recent personal experiences and their growing understanding of the pandemic event. These included the following.

> My article stated, "My guess is that relationships with a strong foundation will survive and may even flourish, whereas those characterized by poor negotiation skills, destructive communication and lack of appreciation are more likely to buckle under the stress." I think this is true. But another person's article stated that China had been hit hard by covid-19 and were under an extremely strict quarantine. Our quarantine had just begun when this was written, masks were not required and many places were still open, including popular date locations like restaurants, bars, and parks. Will our situation become more similar to China as time passes?

Although the means for the SOJ and the AOL both denote integration as do the modes (3) for both classes, the variance between the two is statistically significant. On the surface, this would agree with the findings of Fabriz et al. (2021), reporting greater student satisfaction with synchronous classes. It is possible the difference is a result of the synchronous or asynchronous design, but there appears to be a more likely reason. Perhaps the make-up and percentages of learning types used in the online classes could differ based on course content. For instance, the SOJ's second highest type of learning recorded was human dimension (17.8%), involving not only learning about others but oneself as well. It also calls the student's attention to the human importance and social implications of what they are learning (Fink, 2014). So, it isn't surprising that a class with a strong multicultural focus would have a higher number of human dimension responses. Examples are below.

> Another part of the article that caught my attention was the number of loopholes taken by officials to make it difficult for Black Americans to vote. …it is evident that the struggle has not been addressed…

> My second group introduced me to John Lewis. I now must vote for someone who acknowledges the broken justice in our country and vows to help create a safer America for everyone. A leader who stands with the oppressed is crucial.

By comparison, the jigsaw materials in the AOJ class focused on couple relations during the Covid-19 lockdown and had fewer human dimension statements and noticeably more application learning responses (26.3%). Although Fink's (2014) application can consist of critical, creative, or practical thinking in any combination, it is the latter that is most visible here, with students thinking through the jigsaw process and determining how to complete the assignment.

> …the jigsaw seems harder online. I finally decided that it isn't harder, we're just in a new and difficult situation. We've never experienced a pandemic and it's scary. I told my expert group that my article

> emphasized self-care and that maybe we should just dive in and see what we can find that might help us.
>
> …the jigsaw is difficult on Zoom. If no one is talking, people can simply stop looking at the screen. Or disappear altogether. I finally said, "we're all in this together.… we need each other."

Although the SOJ mean (M = 3.60, SD = 1.407) is higher than the AOL mean (M = 2.86, SD = 1.419), and the difference is significant (p = .003), they may be more similar than implied. Indeed, both have a mode of three, integration. Recall that Fink's (2014) learning types are not hierarchical, as the taxonomy (Anderson & Krathwohl, 2001), but rather interrelated with any one type producing other types. No type is superior to, or more important than, another. Yet, following the order of learning types as introduced by Fink (2014), the human dimension more prominent in the multicultural SOJ class, was numerically coded as four. While application learning in the AOJ, more noticeable in understanding couple relationships during the pandemic lockdown, was coded as a two. It is possible that the significance was more related to the learning required by the course material and therefore perhaps a product of the coding. The SOJ has a higher mean score, but this does not necessarily suggest a superior score. As with Thieu et al. (2022), "students did not all arrive at the same conclusions in their summaries, but they all cited valid results from their articles to back up their claims" (p. 8).

Lastly, note that all participants here were female, and care should be taken in generalizing these results to more diverse settings. Although our Family and Consumer Sciences department typically includes a small percentage of male students, all female classes are not unusual in the Human Development and Family Science major.

Conclusion

Both the SOJ and the AOJ were successful in student satisfaction and student learning, with almost all IDEA (IDEA, 2023) scores were above 4.0/5.0, and not significantly different from each other. However, the AOJ scored significantly lower than the face-to-face sample. As suggested, and since both classes were emergency online learning (Xu & Xue, 2023), this may very well be due to the asynchronous nature of the class. But that could not be determined here. Next, thinking and reasoning (Anderson & Krathwohl, 2001) was well above rote learning for both the SOJ and the AOJ, and both were significantly higher than the face-to-face sample (Anderson et al., 2022). In this respect, the online jigsaws reported better jigsaw results online (e.g., Chang & Benson, 2022; Sadaf et al., 2021). It appears the difference is best explained by the mode of each group. The SOJ and AOJ and mode scores of 5 and 3 respectively, while the face-to-face sample had a mean of two. The course material for the AOJ and the face-to-face jigsaw were the same. Perhaps this is why they were more similar, but that cannot be confidently determined here. Concerning Fink's (2014) types of learning, all three groups were similar in mean and mode, with no significant difference between the online groups and the face-to-face sample. As explained earlier, this appears to be a result of the

secondary types of learning utilized in each class, human dimension for the SOJ and application for the AOJ. The difference is significant, but the learning types (Fink, 2014) were appropriate for the individual course. Jigsaw modifications made here retained student satisfaction and educational value of the face-to-face jigsaw technique and was indeed successful in producing opportunities for critical thinking for most students and consistent, worthwhile types of learning. Findings here also continue to confirm the flexibility of the jigsaw technique (Costouros, 2020).

Finally, two established educational theories were successfully utilized to understand student learning outcomes by identifying levels of cognitive processing (Anderson & Krathwohl, 2001) and types of learning (Fink, 2013). These results are comparable to similar SoTL applications with Anderson et al. (2022) and Anderson (2019). Together, the three measures produced a trustworthy theoretical triangulation for results (Divan et al., 2017).

Implications for Practice

The jigsaw proved to be a trustworthy teaching tool with all three deliveries producing measurable learning. Still, there were some differences to address in teaching. First, AOJ means were significantly lower than the others on IDEA items regarding discussion groups facilitating learning and sharing their perspectives with others from different backgrounds or ethnicities. Regarding the former, the scenarios discussed should be relevant and interesting and evenly divided so that each member is needed to complete the assignment. The topics here were current (i.e., Covid-19, pandemic lockdown) and without simple answers when stereotypes were avoided. Perhaps, when designing the asynchronous course, more time is necessary to clarify assignment expectations. Next, sharing individual insights with others from different backgrounds could also benefit from the change just mentioned. But the instructor must also keep in mind that part of the variance in this item could be a difference in past educational opportunities and success. Some students may take a dualist approach and seek a single right answer and be uneasy about the assignment, while others may be more experienced at producing several possibilities. Likewise, addressing diversity in online classes can be difficult when others' cultural identities are unknown or blocked on the screen (King, 2012b). Jigsaws are successful in discussing cultural and ethnic issues but require the instructor to monitor progress, address any challenges, and keep the class on task (Anderson et al., 2019). However, using Zoom meant the whole class could not always hear the instructor nor the instructor immediately see where they were needed. Also, groups could not hear other groups. I do not mean others' conclusions but rather the busyness of the class and perhaps felt less accountable for their results. Or they experienced the greater need for self-discipline described by an increased demand for self-discipline Xu and Xue (2023).

Another IDEA item not measured as part of this study, "provided meaningful feedback on students' academic performance," indicated both online groups were less satisfied with instructor feedback (SOJ $M = 3.75$, AOJ $M = 3.83$, Face-to-face $M = 4.54$). Though written feedback on this assignment was comparable, general ongoing feedback was likely lacking online. Instructors must be aware that it is

possible that this could result in more summative than formative feedback (Desrochers & Zell, 2023). Possibly, recorded audio feedback could be more effective as it can convey an encouraging tone perhaps missing online. Considering these three items from student feedback, and Alzahrani et al.'s (2023) finding that students report less support in AOL courses, student engagement deserves particular attention in online classes and will require thoughtful planning. Interestingly, all three IDEA items above reflected the student's view of instruction (IDEA notes on instruction, 2023) as opposed to their own learning.

Concerning future research, hopefully it will not be possible to replicate emergency online learning, but it would be quite possible to replicate this study, both face-to-face and online, as well as the development of synchronous and asynchronous courses. It also seems reasonable that the methods used here could be useful with any jigsaw variation (refer to Anderson et al., 2022 for other modified jigsaws). Lastly, it would be worthwhile to examine student motivation along with student satisfaction. Expectancy*value theory (Eggen & Kauchak, 2015) would be valuable here as this model could differentiate whether satisfaction was based more on the student's expectations of success or the value they have for the course, delivery (face-to-face or online), and other factors.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this article.

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